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CONTENTS.

Editorial 849
Electrical Engineering at Brooklyn Polytechnic Institute 852
Electricity on the D., L. & W. Railroad 852
Wireless Communications with a Balloon 852
Annual Report of U. S. Signal Corps 852
Public Tests of the New York Central Electric Locomotive 853
Iron and Steel Institute in Pittsburg 859
The Equipment of the New York Subway 859
Speed Indicators. By Prof. Clarence P. Feldmann 860
An Alternating-Current Relay for Low Frequencies. By Frank F. Fowle 862
Discussion on Single-Phase Railway Motors 863
New Telephone Patents 865
Current News and Notes 867
LETTER TO THE EDITORS:
The Metric Controversy. By Chas. L. Stone 868
Digest of Current Electrical Literature 869
High-Speed Chain Drive in Motor Plants. By George Hill 873
An Air-Cooled Electric Drill 874
Electric Drive for Paper Mill Work 874
Motor Starters 876
Battery Motors 876
"Erieco" Automatic Engine 877
Data as to Gas Generating Plant Economies 877
Variable-Speed Motor and 72-inch Lathe 878
Induction Motors for a Pulp Mill 878
Lineman's Test Set 879
Power Plant at Monterey, Cal. 879
News of the Week 880

WIRES DOWN.

The violent storm that swept over the country last Sunday and Monday left the usual evidences in the shape of a badly paralyzed telegraph service and a disorganized telephone system. Various cities and sections of the country were absolutely cut off from each other for hours. To use the telegraphic phrase: "No business got through." Even trains were held up by the lack of wires to help control their movements. The exchanges of the country did a restricted speculation, and commerce felt severely the lack of its usual means of communication.

Granting the severity of the storm and the celerity with which the damaged circuits were repaired, why should the interchange of news thus be totally stopped? There is no warrant or reason for it. Either the wireless telegraph is a fake and a trivial toy or telegraph managers are badly lacking in the enterprise of their pioneer predecessors. We believe that the wireless is not a fake and is more than a toy. It is the business and duty of the telegraph companies to get the business through, and if they have not got the wires up they ought to get it through with the wires down. We would greatly like to know why our criticism is unfair or unjust, and why each telegraph system is not now equipped with a wireless service at least for the emergencies of winter gales and snowstorms. The case is put strongly, for some kind of explanation by the leaders of commercial telegraphy appears to be in order. Maintenance of telegraph service is absolutely essential to the modern world.

ELECTRICITY ON THE NEW YORK CENTRAL.

In an incredibly short space of time the New York Central Railroad is in receipt of its first electric locomotive and has made highly successful tests with it. Such expedition and such results are very creditable to all concerned. Even if it be conceded that improvements may and will be introduced in the machine's successors, it is evident that the expert, the designer and the manufacturer are very far from the old days of cut-and-try in the electric traction field. Here we have a locomotive in many respects of distinctively new type, which "the first crack out of the box" is able to make speeds up to 75 miles an hour and with loads up to 600 tons makes easily 54 miles an hour. It is obvious that these records must be surpassed in the near future, when conditions and mechanism are more familiar to all concerned. The stern tests to be carried out the coming winter, while they will undoubtedly indicate weak points, will just as surely bring the locomotive wonder to a standard of speed, efficiency and handiness far beyond any yet attained.

The electric locomotive thus tested has already demonstrated not alone its quick acceleration, far beyond anything possible with steam, but its high efficiency at variable speeds, in which respect again the steam locomotive is notoriously inefficient. Another notable point has been the abolition of gear and the mounting of the armature directly upon the axle, so that with the axle it constitutes literally one element. Gearless traction motors hitherto have not been brilliant or conspicuous successes, but this locomotive promises a more flattering tale. We shall be interested to see what the winter months reveal. The present signs indicate a freedom from old causes of failure and the evolution of a new design that "gets there." It will also be extremely instructive to watch the data as to wear

and tear of track. The record of electric street cars as to track is not one of spectacular economy. We have heard a prominent street railway manager say that had his trade been built of silver rail they could hardly have cost more. But it is not an improbable contingency that with this new locomotive and its uniform torque, absence of gearing and freedom from pounding, a remarkable reduction in track depreciation may be recorded.

ENGINEERING EDUCATION.

That a wide difference of opinion exists as to the system of engineering education which can best meet all of the conditions of the present day, is evident to all who have followed even cursorily the discussions on the subject or noted the changes constantly being made in the details of technical courses. There appears to be a general concensus of opinion on only one point, and that is with respect to the relatively small value of so-called practical shop work, which formerly was considered so important an adjunct to electrical and mechanical engineering courses. There also seems to be a growing appreciation of the desirability of concentrating effort in schools on the teaching of fundamentals rather than to endeavor in the span of an undergraduate course to cover also the practice of engineering. Indeed, during recent years the tendency not only of educators but also of employers, appears to be toward the opinion that the proper function of the technical school is to train systematically the thinking faculties concurrently with laying up in the mind of the student a store of basic principles upon which he can draw in his subsequent career as an engineer. This opinion seems to rest upon a firm basis for the reason that in the practice of engineering the essential factor of success is nicely balanced judgment, and this cannot be instilled by rote, but must be learned from contact with actual work involving reputation and at all times one's daily bread. Possessed of this faculty, which will be acquired the more quickly by one who has undergone systematic mental training in youth, the engineer can draw upon his store of fundamental knowledge with a discrimination lacking in the student were it attempted to have him associate intimately the principles as taught, with the practice in which they are to be employed. On the other hand, since the end of technical education is to fit the student for the conditions he has to encounter in future life, it is desirable that the student should have, as far as possible, a knowledge of these conditions in order that at least the general bearing of what is taught may be better appreciated, thereby through association fixing more firmly principles in mind.

A number of plans for thus keeping in touch with the practice of engineering have been suggested and some have been put into effect. One that has been much favored has consisted in courses of lectures to students by practicing engineers. Aside from the inspiration to students through listening to men whom they honor from their achievements, this system has proved faulty in that there is apt to be, aside from lack of pedagogic or expository skill on the part of the lecturers, little connection between the teaching in the class rooms and the exposition in the lecture room. Another method is about to be tried at the Polytechnic Institute of Brooklyn, and this gives promise of being much more fruitful of results. According to this method, the fundamental training of the student is to be carried on by the regular instructors, and the strictly electrotechnical instruction is to be given by a board of engineers acting as consulting professors, whose work is to be properly fitted into the general curriculum. That is to say, the classroom work will prepare for the instruction to be received from the consulting staff, and in turn this instruction will fit the student to appreciate more fully the bearing of what he is taught in the classroom. A particular advantage of this system appears to be that it leaves to the staff of professional educators the pedagogic organization and control of the course of instruction as a whole, and very largely the systematic training of the minds of the students. The art of education is a most comprehensive one, which has occupied the greatest minds from a day doubtless long before Socrates until the present time, and it is scarcely to be expected that engineers busy in the practice of their profession will be proficient in all or even many of its multifarious details. Dealing as it does with the gradual development of the mental faculties, with the logical inculcation of ideas and the fixing of one class of ideas by association with other classes, it is an art requiring the trained exercise of the best powers of the human mind, as well as the faculty of exposition, which is a rare possession. The plan devised by Prof. Sheldon appears to involve a good balance between the skilled teacher and his art, and the outside engineer expounding the conditions which the student should have in mind in laying up his store of fundamental knowledge. The experiment well deserves the attention of those presiding over technical courses, and Prof. Sheldon deserves their thanks for having so ably worked out its details and so reorganized his course that it will be given a fair trial.

THE LONGITUDE OF MANILA AS MEASURED EASTWARD AND WESTWARD.

Prior to the first laying of submarine cables across the Pacific a few years ago, the longitudes of eastern ports could only be determined telegraphically eastward from Greenwich. In this way the longitude of the peak of the dome of Manila Cathedral had been determined by telegraphic signals from Greenwich via Madras and also via Vladivostock. The mean of the two observations (which differed only by 0.46 second) was 8 hours 3 minutes 52.468 seconds east of Greenwich. The laying of the Pacific cables has recently enabled the United States Coast and Geodetic Survey to carry longitude determinations to Manila westward, by telegraphic signals. The exchanges of signals were from San Francisco to Honolulu; from Honolulu to Midway; from Midway to Guam, and from Guam to Manila, over a total length of nearly eight thousand nautical miles of submarine cable. The longitude of the same peak of the Manila Cathedral dome, obtained in this manner, is stated to have been 8 hours, 3 minutes 52.425 seconds east of Greenwich. Consequently, the difference between the longitude of this peak as measured eastward, and as measured westward, by telegraphy, is 0.042 second, or 61.7 ft. Assuming that this dome, with which we are not personally familiar, has a diameter of not less than 125 ft., the United States measurements above referred to put the peak of the dome within the limits of the dome and about sixty feet to the western side, assuming that the pre-existing mean European determination, carried along Asia, to be correct.

The Midway Islands, on the other hand, had received their assigned longitude from the astronomical observations of sailors. The telegraphically determined longitude of the same datum point on the island was within 5.1 seconds of time, or 76.4 seconds of arc. This corresponds to an error of more than a mile, and indicates the relative difference in precision between nautical and telegraphic methods. It is interesting to observe the time of transmission of signals over the cables, as determined from the observations of the survey officers. It varied between 0.118 second, for the shortest cable, and 0.189 second for the longest. The electrostatic capacities of these cables are not stated; but estimating them from the data at hand for similar cables, it would appear that the time of transmission of a signal over these cables is in each case about 3.8 per cent. of the CR time constant of the cables, as measured in farad-ohms, and almost precisely one-third more than the period

of time which, in Kelvin's theory of cable signaling, is taken as the unit, and after the lapse of which the curve of arrival just commences to rise appreciably from the zero line.

THE MEASUREMENT OF SMALL INDUCTANCES.

There are various laboratory methods in use for the measurement of inductances ranging between a millihenry and a kilohenry, at ordinary commercial frequencies. When, however, we seek to measure inductances of only a few meters, or decimals of a microhenry, at wireless telegraph frequencies, the measurement presents considerable difficulty. In the first place, the inductance is liable to be affected by the frequency in some degree, and in the second place the inductance possesses a certain associated capacity, the effect of which is to alter the apparent inductance. The *Physical Review* for October contains an article by Mr. A. H. Taylor on such measurements. The principle employed is similar to that used by Dr. Ives in measuring antenna wave lengths, as recently published in our columns. An oscillating circuit of definite high frequency has the voltage drop from a few centimeters of its conductor led into an auxiliary, or derived, resonant circuit. The latter has a condenser of known capacity, and an inductance partly consisting of a pair of parallel wires with a sliding bridge over them. The resonance of the auxiliary circuit is detected by resting a thermojunction upon one point thereof, and leading this to a sensitive galvanometer. When the small inductance to be measured is introduced into the auxiliary circuit, the slide bridge must be moved along the parallel wires until resonance is again obtained. The change in position of the slider enables the value of the inserted inductance to be determined with a degree of accuracy depending mainly upon the sharpness of the resonance excited.

The method would be capable of great precision if the frequency in the exciting circuit could be kept single, and could be sustained. That is to say, the more complex the oscillatory discharge of the condenser in the exciting circuit, and the more damped its oscillations, the less possible it becomes to detect resonance in the associated test circuit. On the contrary, the purer the simple harmonic oscillation in the exciting circuit, and the more prolonged the series of its oscillations, the better the opportunity for detecting resonance in the associated circuit. Under the conditions practically experimented with, the author of the paper claims a degree of accuracy of about 6 per cent. This would be ample for most practical purposes, if it could be ensured. It seems likely, however, that even if the test could be made with such a degree of accuracy in one particular set of apparatus, a greater range of uncertainty would extend to similar measurements made with different apparatus employing slightly varied conditions or geometrical distributions. The inductances measured descended, however, to the order of one meter, and the frequency at which the measurement was made was of the order either of millions or of tens of millions. It is interesting to observe that a circular loop of wire, about one foot in diameter, has an inductance of about ten meters, or 1 microhenry. A loop of wire about two inches in diameter was found to have an inductance of about a meter, while a little square of wire, approximately one inch on a side, was found to have an inductance of about 90 centimeters.

SPARKING DISTANCES.

The American Institute of Electrical Engineers published, in 1899, a table of sparking distances between opposed needle points in air, as an appendix to the report of its standardizing committee. The sparking distances were given for a series of twenty effective sinusoidal voltages between 5 and 150 kilovolts. These data were obtained from experimental observations of Steinmetz. The table has proved of great value to engineers, and has been widely used in the testing of high-tension, alternating-current apparatus. The spark test is simple, convenient, inexpensive and takes the place of a great variety of expensive apparatus. It is no easy matter to measure 50 kilovolts with any degree of precision, and the difficulty increases with the pressure. The data given in the table referred to represent to a first approximation a straight-line law between the voltage and the sparking distance. To this rough approximation the sparking distance was 2.4 mm., or about 0.1 in. per effective kilovolt. Examined a little more closely, however, the curve is expressed with greater precision as a combination of two straight lines of different slopes. The first line runs to 30 kilovolts, representing 1.37 mm. per kilovolt, and the second beyond this tension, representing 2.4 mm. per kilovolt. The cause of the sudden increase in gradient in the vicinity of 30 kilovolts has not been elucidated. In making tests of this kind it is to be remembered that the points are first set at a measured distance apart, and the alternating-current voltage is then applied and steadily raised until the arc forms across the gap. If the process lasts about half a minute, as it frequently will, the needle emits at high tensions a brush discharge which is audible at a considerable distance, long before the spark leaps; and, in darkness, this brush discharge at the needles is clearly visible.

At the International Congress of St. Louis a paper on this subject was presented by Mr. H. W. Fisher. The results given in this paper were only carried up to 50 kilovolts, but it would seem that with sharp needles the sparking distance followed a straight-line law from one kilovolt to fifty, and represented 1.372 mm. per kilovolt. This practically agrees with the first straight line of the Steinmetz curve in the A. I. E. E. report, but does not bend upward on passing 30 kilovolts. Consequently, although the two curves agree almost exactly at 30 kilovolts, they disagree markedly at 50, the sparking distance for which is 90 mm., according to the A. I. E. E. table, but only 68.6 mm. according to the Fisher curve. The difference is, therefore, 21.4 mm., or nearly one inch in about three. The paper lays great stress upon the necessity of using very sharp points, if reliable results are to be obtained. Needles are popularly supposed to be sharp, but according to this paper not all needles are sufficiently sharp for uniform sparking distances, and it is necessary to examine the points of the sharpest brand of needles optically, in order to select the fittest. Moreover, the paper points out that the ionization of air in the brush discharge prior to sparking may be a fruitful source of divergence in results, having the tendency to increase the sparking distances unduly. In order to reduce the ionization, the needles are set in concave metal cups which presumably protect the needles at their centers from too early a development of brush discharge. At all events, the results are said to be more uniform at high pressures with these cups than without them.

In view of the serious discrepancy between the results in the paper and those in the A. I. E. E. report for pressures exceeding 30 kilovolts, it becomes important to have the matter thoroughly investigated afresh. Meanwhile, the A. I. E. E. data below 30 kilovolts seem to be confirmed and placed on the law of a straight line passing through the origin of the voltage and distance axes. If it be true that it is the maximum cyclic voltage that actually breaks down the air, or in other words that the spark always occurs at the peak of a wave, then the results of the paper, interpreted in terms of maximum peak voltage, instead of R.M.S., or effective voltage, mean that the ratio is very nearly a millimeter per kilovolt. In fact, the kilovolts (maximum) are three per cent. greater than the distance between very sharp needles measured in millimeters. For practical purposes, therefore, at least up to 30 kilovolts, an alternating voltage will jump between sharp needles one millimeter per kilovolt of peak e.m.f. This is fortunately a very easy rule to remember.

Electrical Engineering at Brooklyn Polytechnic Institute.

The course in electrical engineering at the Polytechnic Institute of Brooklyn has been organized along entirely new lines, through the addition to the teaching staff of a corps of consulting professors. Instead of the instruction received from these gentlemen being supplementary to the regular course, their lectures will form an integral part of the curriculum. The regular staff will occupy itself with the teaching of fundamentals, and their technical application will be expounded by a staff of engineers recognized as technical authorities in the several branches. The instruction by the latter will be delivered at evening sessions, and as it will form a complete course from the purely technical standpoint, engineers and others desiring to benefit from such an opportunity for completing their technical education will be enrolled, and at the expiration of a given term of attendance on the course, will be eligible for a degree.

Following is the staff of consulting professors who have thus far received appointments, with the subjects they will teach: Dr. Louis Duncan, electric traction; Dr. F. A. C. Perrine, electric power transmission; Mr. W. S. Barstow, central station engineering; Mr. Charles F. Scott, commercial engineering; Thomas D. Lockwood, telephony, telegraphy and patent practice.

Electricity on the D., L. & W. Railroad.

Another important announcement comes with regard to the adoption of electricity by a large steam railroad system. President W. H. Truesdale, of the Delaware, Lackawanna & Western Railroad, stated this week that the Lackawanna had for some time been making plans looking to the substitution of electricity for steam as a motive power on the suburban lines of the road. These plans, he said, are now so far advanced that the work of installation will begin as soon as a number of grade crossings along the suburban divisions of the Lackawanna have been done away with.

High officials of the Delaware, Lackawanna & Western, aided by experts, have devoted three years to a close study of the various problems likely to arise in connection with the prospective change in the motive power. Unusual interest was taken by officials of the road in the recent trials of electric locomotives at Schenectady, and the same officials have visited the World's Fair at St. Louis and studied the models of such engines on exhibition there.

Another feature which has aroused keen interest among railroad men in this part of the country, inasmuch as it may be an indication that the company intends to extend the electrification of the road even beyond the suburban district, is the large power house now being erected for the Lackawanna road at Scranton, Pa.

While the plant is ostensibly merely for the operation of the electric signal system, it is stated that when the architects drew the plans it was impressed upon them that these must be on lines which would allow for an immense addition, so as to make possible the establishing of a mammoth power plant, presumably to operate the road with electricity. Scranton is too far from the suburban district of this city to make it practicable to have the power plant there, if it were intended merely for suburban use.

President Truesdale said that he was not in a position to say at the present time just when the installation of electric motive power would begin. He declared that "for the time being" there was no intention on the part of the officials to extend the change in motive power beyond "this end" of the system.

Wireless Communications With a Balloon.

On November 11 tests were made at the St. Louis Fair in communicating with a balloon in flight by means of wireless telegraphy. The balloon ascended from the Aeronautic Concourse at the Fair grounds and rose to a height of over a mile. In its ascension the balloon soon disappeared beyond the clouds and remained hidden most of the time while the tests were carried on. Messages were successfully received in the balloon from the wireless tower on the grounds for about an hour and a half. The balloon, according to press dispatches, was equipped with tuning apparatus with which experiments were made. Two coils of copper wire, each 150 ft. in length, were carried, one fastened at the top and coiled around the balloon until it reached the tuner and responder. The other coil was similarly fastened to both instruments, but swung below the car. This was utilized to catch and transmit the vibrations from the instruments in the tower, thus enabling the operator, by adjusting the tuner to keep himself in communication. In order to maintain communication as long as possible Mr. McQueen, the operator, took with him a small quantity of tin-foil, upon which he stood, in order to make a suitable "ground connection," which was the main difficulty to overcome.

It is stated that another experiment will be made, when the balloon will be equipped with both receiving and transmitting instruments. The balloon carried three persons—Mr. Paul Knabenshue, the aeronaut; Mr. A. W. McQueen, the operator, and Mr. Fireman, a passenger. It landed at Brentwood, four miles away from the starting point.

Annual Report of the U. S. Signal Corps.

Gen. A. W. Greely, chief signal officer of the United States Army, in his annual report, gives an interesting account of the work performed by his corps in establishing an all-American telegraphic system in Alaska. The cables used in the Alaskan system would reach from Newfoundland to Ireland, and the land lines from Washington to Texas, there being 2,079 miles of cable, 1,439 miles of land lines, and 107 miles of wireless lines. Southeastern Alaska, the Yukon Valley and the Behring Straits region have been brought into telegraphic communication with the rest of the civilized world.

Gen. Greely says that after thorough consideration he decided to install material of American manufacture to be operated by American soldiers, and to be laid by an American ship, except some cable instruments and machinery. A selected force of men has been so trained that to-day the Signal Corps of the Army is competent to operate in war a submarine cable of any length. "Repairs in Alaska are maintained," the report says, "by parties stationed at log cabins about forty miles apart, one Signal Corps repair man with two assistants from the line of the Army and a dog team being at each cabin. The men meet the terrible condition of hardship and privation uncomplainingly and with a fortitude characteristic of the American soldier." The report says the Nome wireless station has daily and uninterruptedly transmitted the entire telegraphic business of Seward Peninsula, 5,000 words being exchanged one afternoon between Safety Harbor and St. Michael. The Signal Corps of the Army is now regularly operating the longest wireless section of any commercial telegraph system in the world. The annual business of the Seattle-Sitka cable is estimated at $25,000, and during the year there has been spent $56,935 for Alaskan telegrams handled by the Signal Corps.

Speaking of the Philippines, Gen. Greely says the sixteen most important islands of the archipelago are now connected by cable, which lines, he adds, are recognized as indispensable both by the military and civil authorities. During the year there has been collected and deposited in the insular treasury of the Philippines telegraph line receipts to the amount of $58,675, there having been sent, including Government business, all told more than 2,000,000 messages, the net expense being $325,901. The report says it is a matter of the utmost importance that signaling apparatus of suitable character be installed at the more important military defenses along the Atlantic and Pacific Coasts, to permit of intercommunication between the Army and the Navy.

It is strongly urged in the report that steps be taken by the United States to adhere to the International Telegraphy Union and that international regulations to govern wireless telegraphy in time of war be adopted.

Civil Service Examination.

The New York State Civil Service Commission announces that an examination will be held on December 13 for an assistant electrical engineer. Applications for these examinations must be made on or before November 28. Full particulars of the examination and blank applications may be obtained by addressing the chief examiner of the commission at Albany.

Public Tests of the New York Central Electric Locomotive.

THE most important public electric railway tests ever made in the United States were conducted with notable success on November 12, by the New York Central & Hudson River Railroad Company, when the new high-speed electric locomotive built by the General Electric Company and the American Locomotive Company was given its first public trial. The scene of the demonstration was the special section of track laid with third rail between Schenectady and Hoffmans, and the witnesses comprised a number of the leading managers of trunk railroads in America and Canada, managers of electric and street railway systems, electrical engineers and some forty members of the technical and daily press. There were in fact two series of tests during the day, one in the forenoon and one in the afternoon. The first series were undertaken specially for fifty steam railroad men, invited by Vice-President Wilgus, who were carried to the scene of action in a special train leaving New York on Friday night, November 11, and who spent several hours watching and conducting a remarkable series of prearranged and impromptu tests, some of a very practical character and others more spectacular, upon which the mutoscope was very appropriately brought to bear as a supplement to the ordinary camera record. The newspaper contingent came up from New York on Saturday morning by special car to Schenectady under the guidance of Mr. E. H. Mullin, and then by trolley to the track. Thus a memorable and eventful day was spent with results the more surprising when it is remembered that only a bare year has passed since the New York Central authorities began active measures to inaugurate the régime of electricity on that great system. Such swiftness of decision and celerity of movement promise well for the abridgement of the intervening period of change, innovation and revolution before the New York terminal has been perfected on its vaster scale of magnitude and the electric locomotives are plying regularly forty miles in and out of the city.

Although details of the rapid, successive steps in this notable engineering development have been given in these pages, it is necessary to recapitulate a few facts. The New York Central & Hudson River Railroad Company is now electrically equipping its terminal network for a distance of 34 miles on the main line from the Grand Central Station to Croton, near Peekskill, and for 24 miles on the Harlem Division as far as White Plains. It is the intention to handle all the traffic within this district or zone electrically, and the locomotive just given trial is one of thirty to fifty which will be used in the haulage of the through passenger trains, the heaviest of which reach 875 tons in weight and are to be hauled at a maximum speed of 60 to 65 mechanical hp. By the use of the Sprague-General Electric multiple-unit system of control, two or more locomotives can and will be coupled together and operated from the leading cab as a single unit. The motive power may, therefore, be easily adapted to weight of train with no complication in operation and with uniform make-up of train crew. A single electric locomotive will be able to maintain the schedule with a 450-ton train, two locomotives being coupled together for heavier trains.

This change of motive power is confidently expected to show marked economy in the electrified part of the railroad as a whole and a sharp increase in the suburban traffic, on account of the frequency of service, the greater acceleration, the purification of the Park Avenue tunnel, as required by law, and the general increase in the comfort, convenience and cleanliness of the methods adopted. As already noted, one step in the change of motive power has been the location of two large central turbo-generator power plants, one on each flank of the district served, namely, at Yonkers on the Hudson and Port Morris on Long Island Sound. Each of these plants, already designed and in embryo construction, is to have an ultimate capacity of 30,000 kw, with an auxiliary system of sub-

FIG. 1.—ELECTRIC LOCOMOTIVE FOR N. Y. C. & H. R. R. R. CO.

stations and storage batteries and an interconnection that will enable either plant to do the whole duty and carry the entire load of a train service far beyond that which depends upon the present steam schedule.

The first locomotive for this work, tested last Saturday (Fig. 1), consists of four driving axles on each of which is mounted without intermediate gearing, the armature of a motor having a normal rating of 550 hp. The total rated capacity of the locomotive is 2,200 hp, although for short periods a considerably greater power may be developed, making it more powerful than the largest steam locomotive in existence. Hitherto gearless locomotives have been built with the armature of the electric motors mounted on quills and spring-suspended from the driving wheels. In the new locomotive the use of spring-suspended quills is dispensed with, the armature being mounted rigidly upon the axle, thus reducing the bearings to those of the pony trucks and the main journals, all of which are outside of the driving wheels. The motor has two poles with flat faces so as to permit a large relative vertical movement between armature and poles as the latter move up and down with the riding of the frame upon the springs.

A longitudinal section of the locomotive frame is shown in Fig. 2. The main frame is of cast steel and forms not only the mechanical frame of the locomotive but also part of the magnetic circuit of the electric motors. It will be seen that the armatures are arranged in tandem, the end pole pieces being cast as part of the end frames

and the double pole pieces between the armatures being carried by heavy steel transoms bolted to the side frame and forming part of the magnetic circuit as well as cross braces for the truck. The field coils are wound upon metal spools, which are bolted upon the pole pieces. Proper distribution and division of the weight of the locomotive among the axles has been accomplished by suspending the main frame and superstructure from a system of half elliptic springs and equalized levers of forged steel, the whole being taining master controllers, engineers' valves and switches and valves required for operating sanding, whistling and bell ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and is arranged so as to be easily manipulated from the operator's seat, while at the same time a practically unobstructed view to front and rear may be obtained from the windows. The air gauge, meters, etc., are located so as to be as easily read by the driver. There is a central corridor extending through the cab so

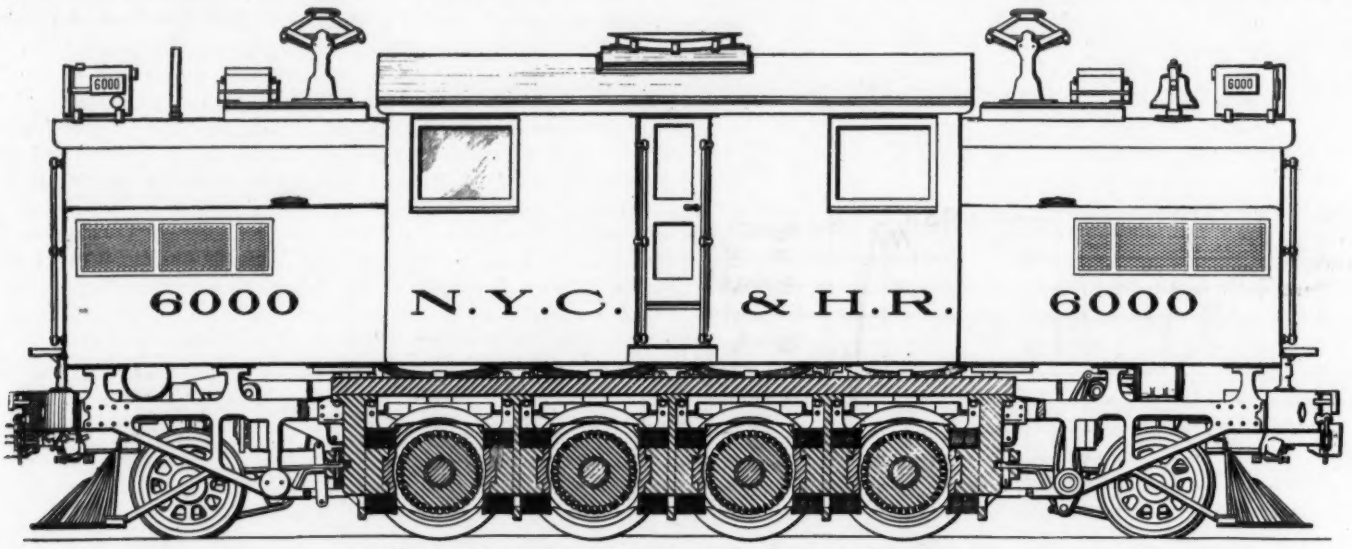


FIG. 2.—LONGITUDINAL SECTION OF ELECTRIC LOCOMOTIVE.

so arranged as to cross-equalize the load and to furnish three points of support (Fig. 3). This construction, besides being strong and simple in design, greatly facilitates repairs and renewals, as an armature with its wheels and axle may be removed by lowering the complete element without disturbing the fields or any other part of the locomotive and a new element inserted in its place. All parts are also especially accessible for inspection and cleaning.

The pony trucks are of the radial type and are pivoted by means of radius bars to the end frame of the main truck. The frame of the locomotive immediately above the trucks is supported by means of suitable links, so that the truck is free to swing about its center and is self-centering on a straight track. This design is similar to the standard construction adopted by the New York Central & Hudson River Railroad Company for its steam locomotives.

The brush holders are mounted on insulated supports attached to the spring saddle over the axle journal, thus maintaining a fixed position of the brush holder in relation to the commutator. These brush holders are made adjustable so as to allow for wear of the

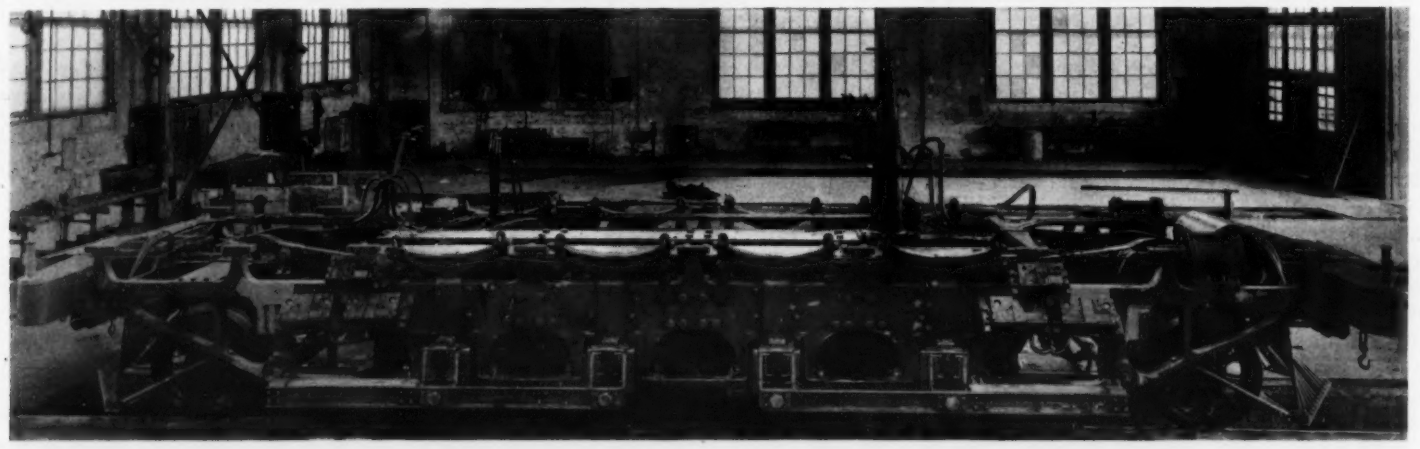


FIG. 3.—LOCOMOTIVE PARTLY ASSEMBLED.

commutator and journal bearings. The dead weight on the axle is not materially greater than is customary with steam locomotives and in addition there is no unbalanced weight to produce vibration with attendant injuries to track and roadbed construction. The actual reduction in the expense of maintaining the rails and roadbed, due to the absence of pounding and rolling, will have an important bearing on the up-keep of the permanent way.

The superstructure consists of a central cab for the operator con-

as to permit access from the locomotive to the cars behind, and the contactors, rheostats and reversers are arranged along the sides of these corridors in boxes of sheet steel, which are sheathed on the inside with fire-proof insulating material. All of these appliances are, therefore, easily accessible for repairs or inspection (Fig. 4).

The control system permits three running connections, namely four motors in series, two groups of two in parallel series and all four motors in parallel. The motor reverser, contactors, rheostats and other controlling appliances are all of the well-known Sprague-General Electric multiple-unit type. The master controller, Figs. 5 and 6, however, is fitted with a special operating lever about 24 in. long and capable of being moved through an angle of about 75°. A current limiting device is provided in the master controller and consists of a friction clutch operated by an electric magnet, which is energized by the current passing through one of the motors, the arrangement being such that when the current exceeds a pre-determined amount the cylinder cannot be rotated further until the current has fallen sufficiently to allow the relay to drop. As long as the current does not exceed the desired limit, the automatic feature is not in operation.

In the operator's cab there is placed a General Electric motor-driven air compressor having a capacity of 75 cu. ft. of free air per minute and consisting of a twin vertical cylinder compressor driven by two 600-volt, direct-current series motors. The compressor is controlled by a governor which automatically cuts the motors in and out of circuit when the air pressure falls below 125 pounds or

rises about 135 pounds. A reduction in air pressure sufficient to actuate any governor simultaneously starts up the air compressors in both locomotives when running double-headed, and likewise when the air pressure has been raised and any one air compressor is closed down the other will be cut out of service. The locomotive is equipped with Westinghouse air brakes.

Current is collected from the third rail by multiple-contact, spring-actuated third rail shoes (Fig. 7), whose supports are carried on channel irons attached to the journal box. There are four of these shoes on each side of the locomotive. Part of the third rail is left exposed and part of it is protected by a hood. The region around Hoffmans is noted for heavy snow and high winds. In the yards at the terminals the large number of switches and crossings necessitates an overhead construction in places, and additional contacts are, therefore, mounted on the top of the locomotive for collecting current when the locomotive is passing over these points (Fig. 9).

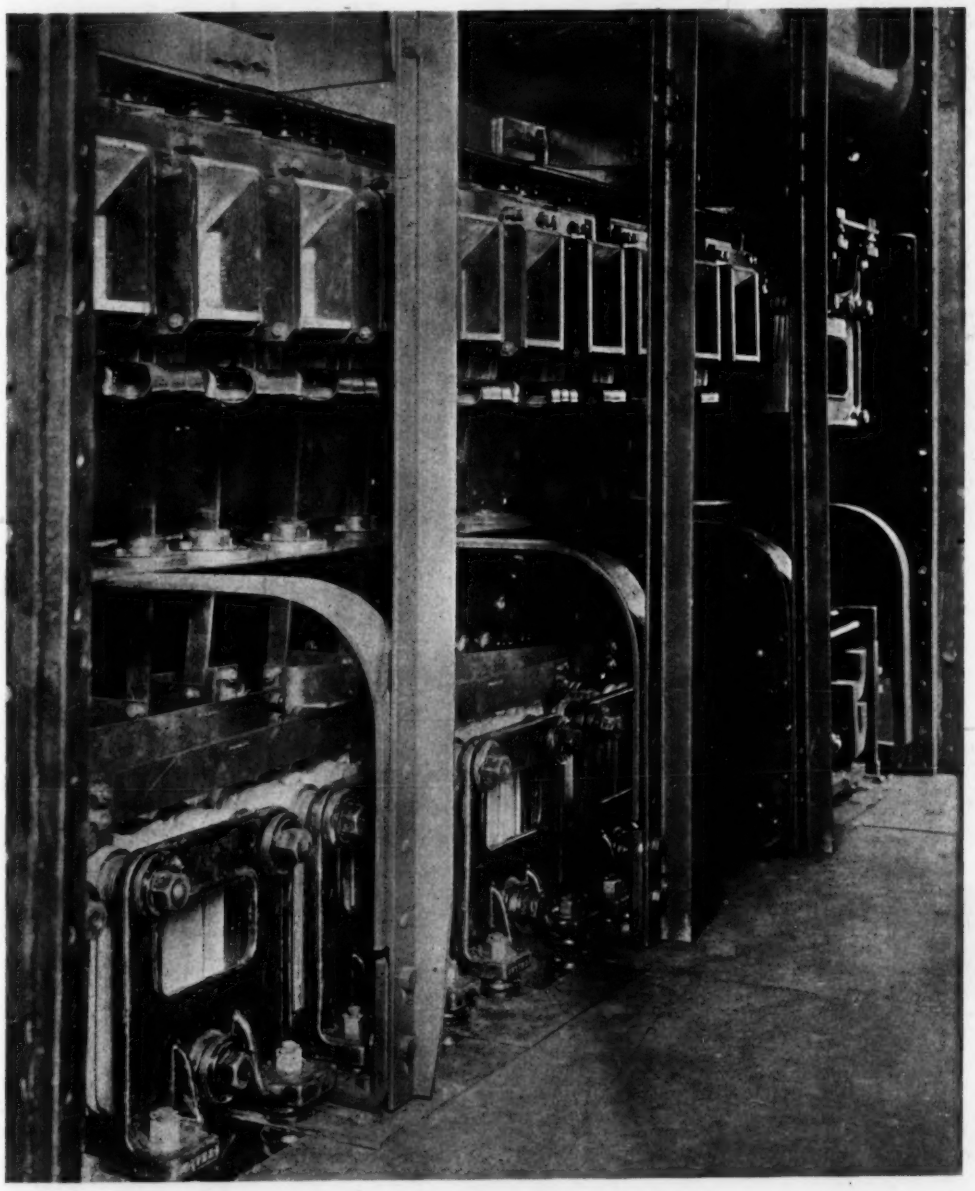


FIG. 4.—CONTACTORS AND RHEOSTATS IN CAB CORRIDOR.

This device may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse (Fig. 8) is placed in circuit with each shoe and overhead contact device, so as to secure protection in case of accidental short-circuit. The overhead fuse box can be seen just behind the locomotive bell. The shoe fuse boxes can be seen grouped, in inclined positions, under the cab, each side of the steps, and vertically above the shoes.

Current for operating the locomotive is furnished by the General Electric Company, and for this purpose there has been installed in the new power house at the Schenectady plant a 2,000-kw, three-phase, 25-cycle, Curtis turbo-generator delivering 11,000 volts to the line. A special high-tension transmission line has been constructed from the power station for a distance of five miles to the sub-station at Wyatts. This sub-station (Fig. 9) contains a 1,500-kw, 650-volt, 25-cycle General Electric rotary converter with three static air-cooled transformers for reducing the line potential from 11,000 to 460 volts, and a switchboard consisting of a 600-volt, direct-current rotary converter panel, an alternating-current starting panel and a high-tension panel with electrically operated type H oil switch (Fig. 10). The rotary converter is self-starting from the alternating-current end, thus requiring no synchronizing or other complications when throwing the machine into service. The step-down transformers are provided with taps giving one-third, two-thirds and full voltage for starting the rotary converter, these voltages being applied successively by means of double-throw lever switches. The machine starts freely and easily without sparking and without drawing more than full load current from the line. The apparatus in the sub-station, the location and arrangement of same, the width and dimensions are in general as proposed for the sub-stations to be built within the electric zone at the New York City terminal, so that practical experience with the plant may be obtained while the locomotive tests are being made and in advance of construction.

This power station, transmission line, sub-station equipment and six miles of track is undoubtedly the most complete testing plant ever provided for trial of electric railroad motive power, and with the facilities afforded in addition to testing the new locomotives much interesting and valuable electric railroad information will unquestionably be obtained.

The general dimensions and data applying to the locomotive are as follows:

No. of driving wheels	8
No. of pony trucks	2
Total weight of locomotive	95 tons
Weight on drivers	69 tons
Rigid wheel base	13 ft.
Total wheel base	27 ft.
Length over buffer platforms	37 ft.
Extreme width	10 ft.
Height to top of cab	14 ft. 4 in.
Diameter of drivers	44 in.
Diameter of pony truck wheels	36 in.
Diameter of driving axles	8.5 in.
Normal rated horse-power of locomotive	2200
Maximum horse-power	3000
Normal draw bar pull	20,400 lbs.
Maximum starting draw bar pull	32,000 lbs.
Speed with 500-ton train	60 m.p.h.
Voltage of current supply	600
Normal full load current	50 amperes
Maximum full load current	4300 amperes
No. of motors	4
Type of motor	G.E.-84-A
Rating of each motor	550-H.P.

Owing to the fact that only a portion of the six-mile track to be used for testing is available as yet—about 4 miles— no complete locomotive tests have been made. There has been installed in the cab a full set of recording instruments, and records have been obtained of some of the preliminary runs made to test the bearings and running qualities of the locomotive. Although these records will be superseded or supplemented by careful tests made on the full length of track, bonded and with sufficient feeders supplied to minimize the drop, they indicate in a general way what may be expected of the locomotive running in regular service. Curve sheets are here shown (Figs. 13, 14, 15 and 16) giving speed, current, input and voltage at the locomotive all on a time basis, with an eight-car train weighing 336 tons, and a four-car train weighing 170 tons, both exclusive of locomotive. The total weight of train, including locomotive and passengers, was 431 tons and 265 tons for the eight-car and four-car trains, respectively.

Two sets of curves are shown, two running tests reaching as high a maximum speed as possible with the length of track available, and two sets of starting tests showing the more rapid rate of acceleration possible with the higher maintained voltage available near the sub-station. The maximum speeds reached were 63 miles per hour with an eight-car train and 72 miles per hour with a four-car train. It will be noted that the trains were still accelerating at these speeds, but the length of track so far equipped did not permit attaining higher speeds.

The New York Central locomotives are not designed for abnormally high speeds at intervals, but rather to obtain a high average

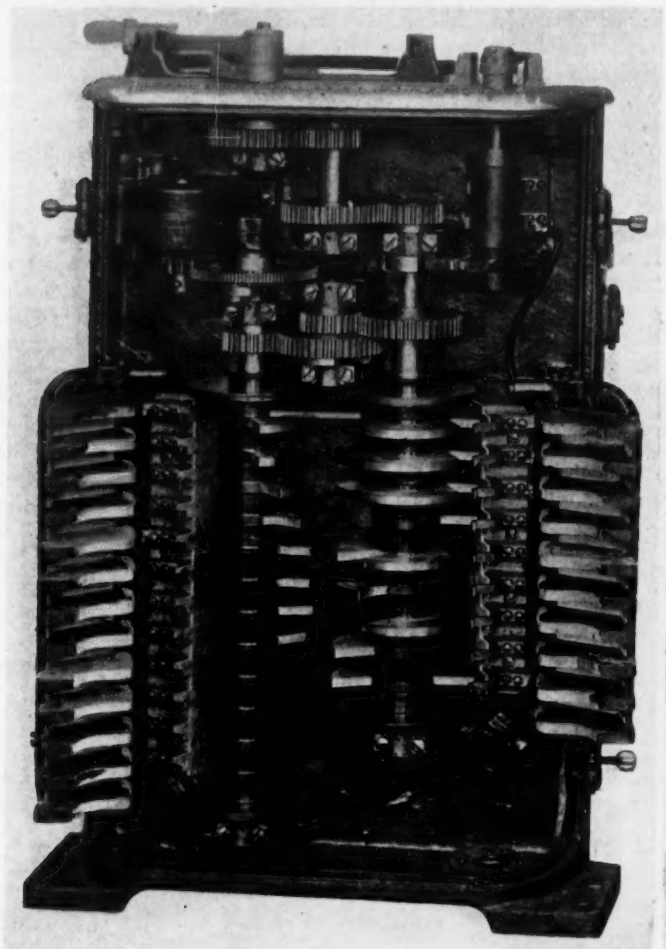


FIG. 5.—CONTROLLER WITHOUT CASE.

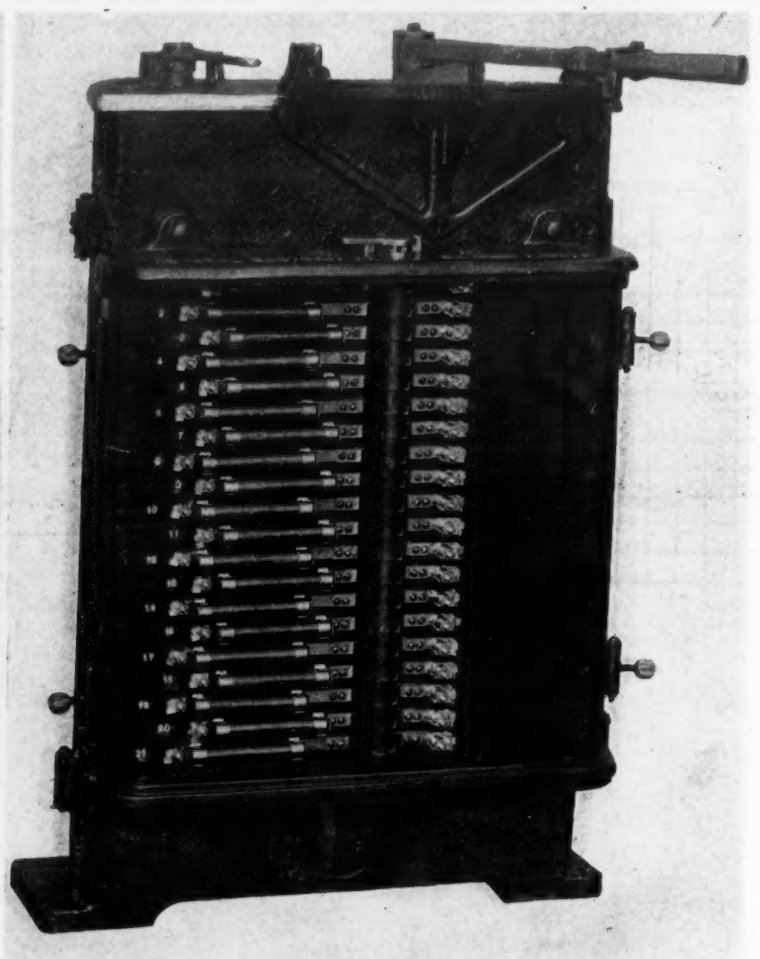


FIG. 6.—BACK OF MASTER CONTROLLER, SHOWING CUT-OUT SWITCH.

schedule, due to their ability to accelerate more rapidly than is possible with the present steam locomotives. In the starting tests a speed of 30 miles per hour was reached in 60 seconds with an eight-car train weighing, including the locomotive, 431 tons, corresponding to an acceleration of one-half mile per hour per second. During certain periods of the acceleration the increase in speed amounts to .6 miles per hour per second, calling for a tractive effort of approximately 27,000 pounds developed at the rim of the locomotive drivers. This value was somewhat exceeded with the four-car train, where a momentary input of 4,200 amp. developed a tractive effort of 31,000 pounds at the drivers with a coefficient of traction of 22.5 per cent. of weight on drivers. The average rate of acceleration with the four-car train, weighing, including the loco-

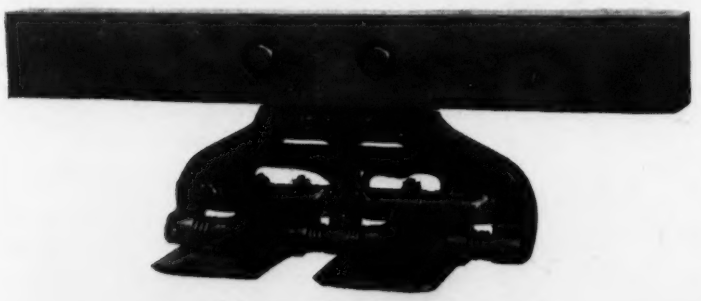


FIG. 7.—THIRD RAIL SHOE.

FIG. 8.—1500-AMP. FUSE BOX, WITHOUT COVER.

FIG. 9.—VIEW OF TRACK, SHOWING HOODED THIRD RAIL, OVERHEAD CONTACT AND THE SUB-STATION.

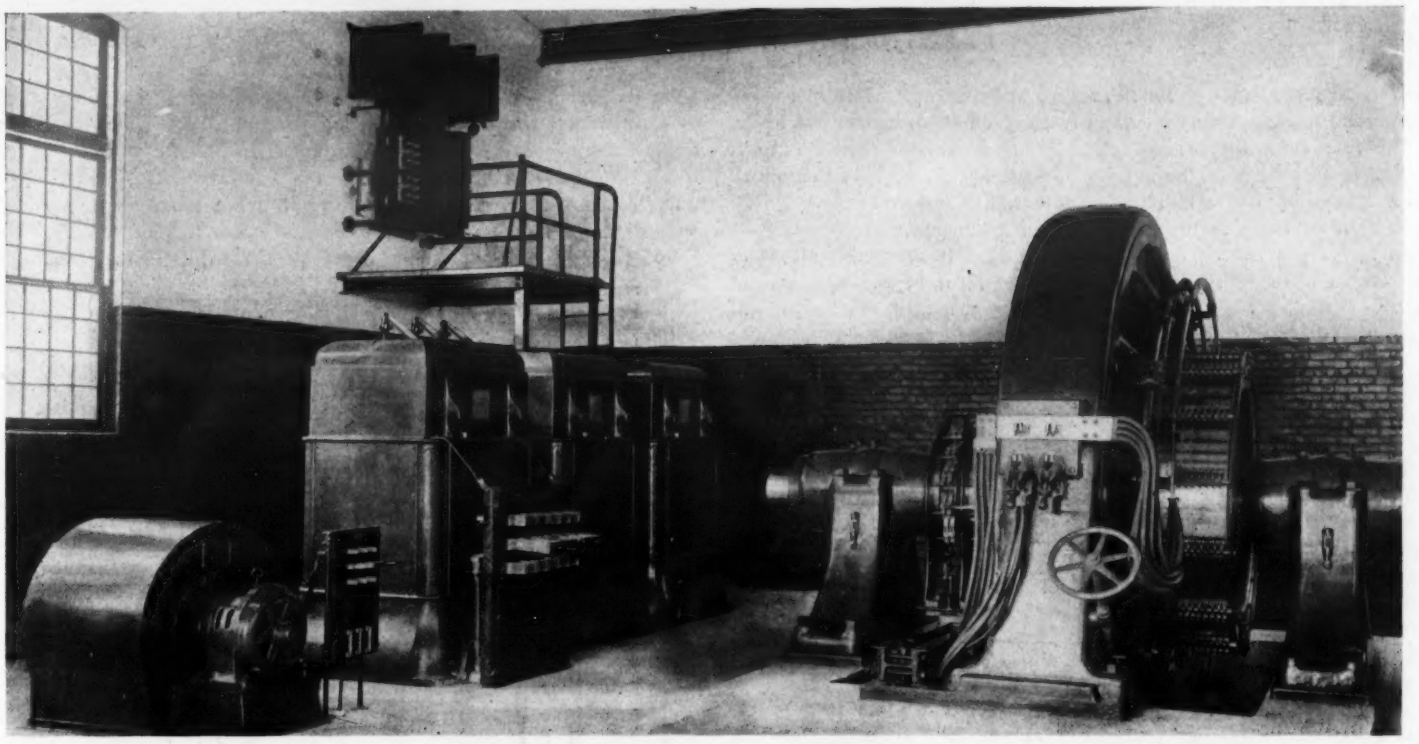


FIG. 10.—INTERIOR OF SUB-STATION.

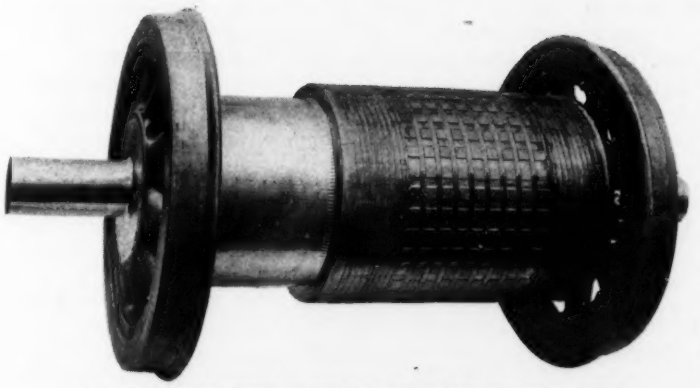


FIG. 11.—ARMATURE MOUNTED DIRECTLY ON CAR AXLE.

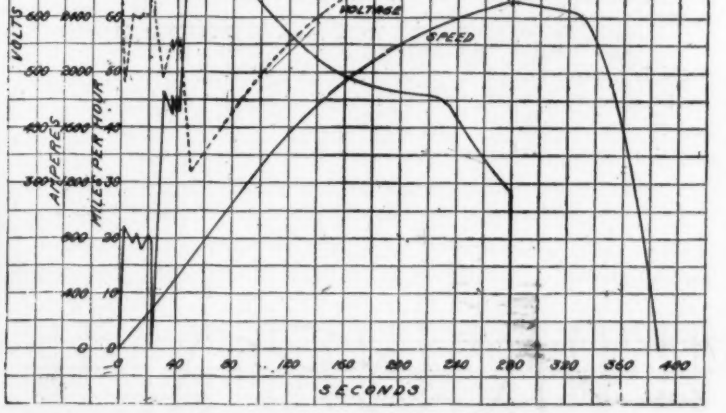


FIG. 13.—PRELIMINARY SPEED RUN NO. 1.

FIG. 12.—ELECTRIC LOCOMOTIVE WITH TEST TRAIN.

PUBLIC TESTS OF NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

motive, 265 tons, was 30 miles in 37½ seconds, or .8 mile per hour per second, calling for an average tractive effort of 22,000 pounds.

The maximum input recorded, 4,200 amp. at 460 volts, or 1,935 kw, gives an output of the motors of 2,200 hp available at the wheel. With 4,200 amp. and a maintained potential of 600 volts there would have been an input to the locomotive of 2,520 kw, corresponding to 2,870 hp output of the motors. This output is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22.5 per cent. of the weight upon the drivers, thus placing this electric locomotive in advance of any steam locomotive yet built. No service capacity temperature runs have been made as yet, and the preliminary tests have not shown any appreciable warming up of the motors sufficiently to take thermometer readings.

Throughout both the starting and running tests the electric locomotive shows its remarkable smoothless and steadiness in running, a distinct contrast in this respect to the steam locomotive, especially should the latter be forced to perform the work here shown to be accomplished by the electric locomotive. The elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor characteristics shows a maximum efficiency of approximately 93 per cent., this value being fully 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent. even at the free running speed of the locomotive alone, in contrast to the 85 per cent. or less which would be a good showing for a locomotive provided with geared motors. The simple construction and high efficiency made possible with this design of gearless motor, together with the minimum cost of repairs attending such a construction, makes the direct-current, gearless motor type of locomotive a distinct forward step in electric locomotive construction.

Compared with existing steam practice, it is interesting to note that the heaviest "Atlantic" type locomotive of the New York Central Company weighs approximately 150 tons, including the tender, on which but 47 tons are on two pairs of drivers. It will, therefore, be seen that for every pound of effective drawbar pull the steam locomotive has a weight of over 12 pounds, as compared with but 6 pounds with the electric locomotive. Therefore, in a single electric unit, over 25 per cent. greater weight is available for traction than with the largest steam passenger locomotive now in use,

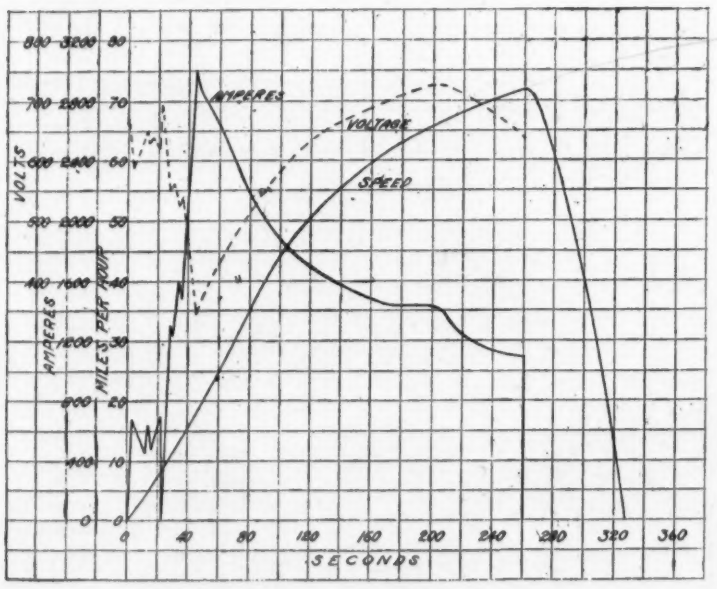


FIG. 14.—PRELIMINARY SPEED RUN NO. 2.

with 37 per cent. less dead weight and with 28 per cent. less weight on each axle. Moreover, the electric locomotive will, of course, have an entire absence of counterbalancing of driving wheels and twist from reciprocal motion, both of which in the steam locomotives are so destructive to track and roadbed.

In addition to the tests above recorded, Mr. Wilgus made several with the special train, as noted above, before the series arranged by the General Electric Company. They were extremely interesting and suggestive, especially as viewed from the standpoint of the steam railroad experts who constituted the party aboard. The first runs made early in the morning were effected with the full special train of seven cars as follows, with weights: Electric locomotive, 95 tons; buffet car, No. 479, 50 tons; Pullman car "Navarine," 52.5 tons; Pullman car "Marathon," 52.5 tons; Pullman car "Saxony," 59 tons; Pullman car "Hebron," 60 tons; private car, No. 498, 49.5 tons; private car, No. 44, 60 tons; total, 478.5 tons.

Runs were then made with a lighter train, including all of the above equipment, except the two private cars, thus making the total

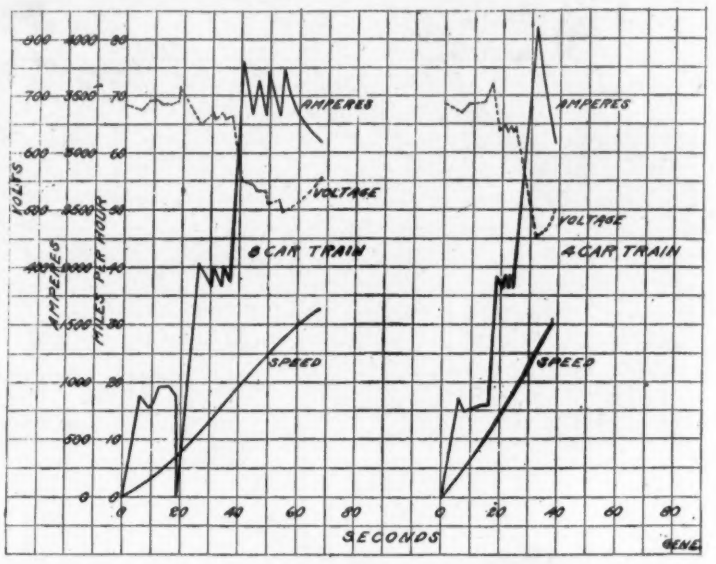


FIG. 15.—STARTING TEST.

weight, including the locomotive, 369 tons. Speeds up to 65 miles per hour were easily attained, but the short length of the track stood in the way of the highest achievement. One very noteworthy test was that which brought the total train weight up to about 600 tons, two more private cars being hitched on—one, that of Mr. George Westinghouse, who came over specially from the Berkshires to attend the exercises. With this train a speed just short of 54 miles an hour was attained, the highest ammeter reading in the cab on the run being 3,400 amp., which at a full line voltage of 600 would represent 2,140 kw. The run up and down the track under these conditions was made very smoothly and easily; in fact, the absence of jolting and swaying in the locomotive cab was noticeable at all times.

One interesting exhibition was that made in the morning, when the electric train "picked up" the No. 3 fast express going west and indulged in a brief but very decisive spurt with it. Under the instructions of Mr. Wilgus, the electric locomotive was held under slight headway until the express was well abreast going at full speed. No. 6000 was then let out and accelerated so quickly that before a mile had been run she had pulled her whole train well ahead of the mail express and inside of two miles had a striking lead, although the steam locomotive had all steam on and was stoking and smoking furiously. Similar results were shown in casual runs against the pony locomotive "Mohawk" on an adjoining track.

A question that arises in connection with the application of electricity to the heavy service of the New York Central is that of heating. It is expected that in the majority of instances sufficient heat will be retained in the trains delivered to the electric locomotive at the end of the steam run to carry the cars to the terminal without any additional heat from the locomotive. To meet an emergency or contingency of this kind, however, it is probable that a flash boiler of the automobile type will be used on the electric locomotive, occupying but a small space in the operator's central cab, where at present a good deal of room is available. It will be understood that for the ordinary suburban service of the company within the electrical area, the usual electric heating equipment now familiar on street cars will be installed. But, of course, at this early stage, all kinds of passenger cars will be coming in as usual over the New York Central from foreign systems where electric traction has not yet been adopted, and for these at least some such provision as that noted above is in contemplation.

The electric traction commission of the New York Central was represented at the tests by Messrs. Wilgus, Sprague, Arnold, Deems and Katte. Railroad officials included President Underwood, of

the Erie; Vice-President Rea, of the Pennsylvania; Vice-President Voorhees, of the Philadelphia & Reading; General Superintendent Cutter, of the Lehigh Valley; Vice-President Besler, of the Central Railroad of New Jersey; President Vreeland, of the New York City Street Railway Company, and many others not less well known. The New York Central contingent comprised Vice-Presidents Rossiter and Van Etten; Mr. George H. Daniels, general passenger agent, and numerous heads of staff. The General Electric Company was represented by Vice-Presidents Eugene Griffin, E. W. Rice, Jr., and Prof. Elihu Thomson, as well as by Messrs. Lovejoy, Potter, Armstrong and many of the Schenectady and New York force. Among engineers were noted Mr. J. O'Rourke, who is building the Pennsylvania tunnel under the Hudson River, and Mr. C. Sooysmith.

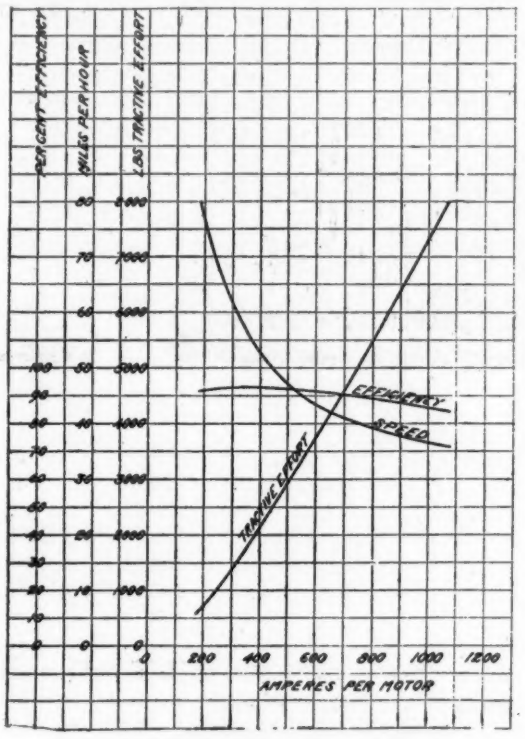


FIG. 16.—CHARACTERISTIC CURVES.

Iron and Steel Institute in Pittsburg.

The Westinghouse Electric & Manufacturing Company, on Wednesday, November 2, entertained at its Pittsburg works the members of the Iron and Steel Institute, showing them through the various works during the afternoon, giving to them a banquet in the evening. The banquet took place in the largest aisle of the works of the Westinghouse Electric & Manufacturing Company, its length being one-third of a mile. The portion of the aisle set apart for the banquet was beautifully decorated by flags of the United States and Great Britain. The lighting effect was beautiful, many Bremer lamps being strung from the ceiling and Cooper Hewitt lamps suspended from the sides, the latter to make possible the taking of photographs. The tables were almost hidden beneath the chrysanthemums, roses and other flowers used for ornamentation. A lounging room was provided for the convenience of the guests, where writing materials and souvenir postal cards, showing interior and exterior views of the works, were provided.

A most unique souvenir was given to each person present at the dinner, it being in the form of an induction motor and small enough to permit of its being carried in the pocket. The occasion was marked as being one of the most successful and largest attended. There were over 600 persons invited, and fully 600 joined in the merrymaking.

Sir James Kitson, past-president of the British Iron and Steel Institute, thanked the city of Pittsburg, on behalf of President Carnegie, for the unusual kindnesses shown to the British visiting manufacturers, and Mr. Westinghouse indicated his great pleasure in being honored on this occasion by the presence of so many friends from abroad.

The Equipment of the New York Subway.

Considerable public attention has been attracted by the letter written by Mr. Nikola Tesla to the New York *Sun*, after the opening of the New York Subway, criticising the equipment. This letter was reprinted in our issue of November 5. Mr. L. B. Stillwell, the electrical director of the Interborough Company, has now replied to the letter and we cite his response in full below:

"So far as engineers are concerned, the letter of my friend, Mr. Tesla, printed in your paper of November 1, answered itself, and but for his reflection upon the business policy of Mr. Belmont and his associates no comment would be necessary. In stating that 'a mistake was made in not asking electric companies to furnish the best instead of the cheapest equipment,' however, Mr. Tesla makes a serious charge, directed, apparently, not at the engineers of the Interborough Rapid Transit Company, but at its management, and in justice to these gentlemen, who have performed their part in a quasi-public enterprise in a most liberal and thorough manner, it seems proper for me, as the engineer responsible for the electrical equipment, to say that Mr. Tesla's statement is entirely erroneous.

"In providing an equipment costing more than twice as much as was contemplated at the time the contract with the city was executed, Mr. Belmont and his associate directors have imposed upon their engineering advisers no limit of cost. If any mistake in the selection of the electrical equipment has been made (and Mr. Tesla offers no evidence that such is the case), the mistake is mine and not Mr. Belmont's. It is a pleasure to emphasize the fact that no company with which I have been connected in carrying out an important work of engineering construction involving the expenditure of large sums of money ever impressed more strongly upon its engineering advisers the wish of its management to secure the best attainable results, nor allowed its technical staff greater latitude with respect to methods and expenditure.

"Mr. Tesla's letter cannot be discussed with profit in the columns of the daily press, and my recollection of what he has done for electrical progress in the past is so vivid that I am disinclined to comment upon his technical suggestions, which perhaps appear more plausible to the average reader than to the engineer. I would suggest to Mr. Tesla, however, that a paper from him containing specific and definite criticism of the electrical equipment of the Subway might be presented before the American Institute of Electrical Engineers, and that if he will present such a paper I shall be glad to meet him upon such an occasion for the purpose of a full and frank discussion."

It is to be hoped that Mr. Tesla will adopt Mr. Stillwell's suggestion of appearing before the Institute.

Ohio Engineers.

The Ohio Society of Mechanical, Electrical and Steam Engineers will hold its ninth meeting at Canton Nov. 18 and 19. An interesting programme has been prepared and several valuable papers are scheduled, among them being "Some Facts and Features About Electric Meters," by H. S. Fashbaugh; "Notes on Solenoid Electric Mechanical Governors, as Applied to Turbines and Impact Wheels, a New Departure on Water Wheel Governors," by Frank S. Replogle; "Boilers and Furnaces," by W. C. McCracken; "Gas Engines in Power Plants," by Prof. William T. Magruder; "Electrically Driven Chapman Valves," by Herbert E. Stone.

Consumption of Natural Gas.

Pennsylvania, West Virginia, Indiana and Ohio produced 94 per cent. of the value of natural gas in 1903. Indiana alone had a decrease of production in 1903 as compared with 1902. The volume of natural gas produced in 1903 amounted to 238,769,067,000 cu. ft. at atmospheric pressure and represented approximately 5,968,725 tons. If the density should remain the same throughout, this quantity would fill a reservoir 1.62 miles high, with an area of a square mile of ground, or it would fill a pipe that would encircle the earth at the equator and that had an internal diameter of 49 ft. Its heating value would equal that of 11,938,453 tons of bituminous coal. Natural gas was burned during 1903 by 627,047 domestic consumers and 7,222 manufacturers.

Speed Indicators.

BY PROF. CLARENCE P. FELDMANN.

QUITE a variety of different devices have been proposed and employed for speed indicators with more or less success. It is true that the manufacturers have greatly improved the system of oiling, so that these instruments work more satisfactorily now; but they are by no means exact, the inaccuracy reaching 3 to 4 per cent. after a month's use.

A second system also employing centrifugal force is Braun's so-called "gyrometer." Here the motion is imparted to a fluid, or speaking more precisely, to a revolving column of mercury, which rises in a glass tube in which it is enclosed, and shows a corresponding depression near the axis of the column. A vertical section through this axis shows that the liquid has the shape of a parabola, the depression being a function of the speed of revolution, i. e., increasing with increasing speed. This depression is, however, very small for a given range and varies but little with a small variation of speed. In order to increase the speed of the revolving mercury the tube must be high and pulleys must be used in many cases. The manufacturers of cream separators tried to use this apparatus, but gave it up as the price was somewhat high and the pulleys wore off and gave trouble after a short while.

An improvement of this system may be obtained by using some lighter fluid, which is placed in a special tube on top of the mercury, but even then the matter is complicated, as this tube must partake in the revolutions, and though the depression of the lighter fluid is largely increased, it is difficult to take a correct reading on this revolving tube. Another improvement endeavors to overcome this difficulty by placing a float on top of the revolving liquid and multiplying the corresponding vertical movements of this float by means of levers. But even this system has found no practical application on any large scale. It was due to Haubold, of Chemnitz; the price of the apparatus for cream separators with their limited range of speed variations was between 50 and 60 marks, as compared to 15 and 20 marks for a simple apparatus of this type.

All of the devices mentioned thus far are only applicable in the immediate neighborhood of the revolving shaft. In order to show the speed at a distant point, electric means of communication must be employed. This has also been done by several inventors with greater or lesser success.

For instance, a direct-current dynamo, driven by means of a pulley from the revolving shaft to be tested, could be used to show the speed of the shaft by means of a simple voltmeter whose scale may be graduated in volts or in revolutions per minute of the dynamo, or of the primary driving shaft. All these values being proportional to one another, it could for any vehicle be graduated in miles per hour, which number of a given diameter of the wheels is also proportional to the speed of the shafts. The disadvantages of this type of speed indicator are primarily the use of a commutator, and brushes which have to be taken care of, and secondly the rather high first cost.

Instead of a direct-current dynamo, an alternator could be excited from a direct-current source or could have permanent magnets. Such arrangements have been used by several firms, for instance by Lahmeyer & Co., of Frankfort-a-Main; by Siemens & Halske, of Berlin, and others.

Lahmeyer & Co. used direct current taken from a battery, interrupted it by means of a revolving commutator, sent it through a transformer and measured it by means of an alternating-current voltmeter. The device is rather complicated on account of the revolving commutator, which gives rise to sparking, and on account of the relatively low sensitiveness of alternating-current voltmeters, and may be damaged by shocks if used on railway locomotives, auto cars, etc.

If an alternating-current dynamo of the usual type is being used as transmitter or sounder, the variations of the e.m.f. of the exciting source (battery) must be taken account of. It is, therefore, preferable to use permanent instead of electromagnets. This has been done by some firms, but they experienced trouble by the alternation of the permanent magnets, and had to change or correct the scale of the voltmeter according to these variations. If hot-wire instruments are used as receivers, as has been done by the Vulcan Speed Indicator Company, of London, for automobiles, it is necessary to impart high speeds to the generator in order to get good indications, and besides the hot-wire instruments are easily damaged by the mechanical shocks which are inevitable on board of automobiles, locomotives, etc.

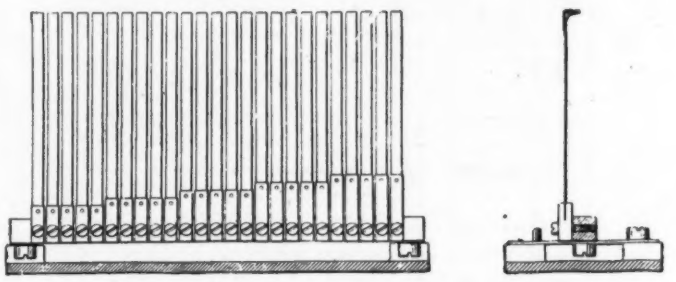


FIG. 2.—SPEED INDICATOR.

The only system which has given complete satisfaction to the Royal Prussian Railway Administration as a result of recent prolonged high speed railway tests made on actual machines and in actual service is the "Frahm Indicator," which has been adapted for the locomotives of this largest German railway concern.

On board of steamships the German navy has until now only used a system of speed indicator due to Schlotfeld. This system consists in pumping mercury by means of a small centrifugal pump from one space into another. In one of these spaces a vacuum is produced and the higher the speed of the pumps the higher the vacuum will be. This is connected in the usual way through tubes to a manometer and indicator. Obviously this apparatus is very complicated and troublesome; the mercury is difficult to keep clean, the springs of the manometer have to be frequently calibrated, and the pointers have to be set according to these calibrations. Besides the price is relatively high, i. e., 800 marks per instrument if six receivers are attached to one sender.

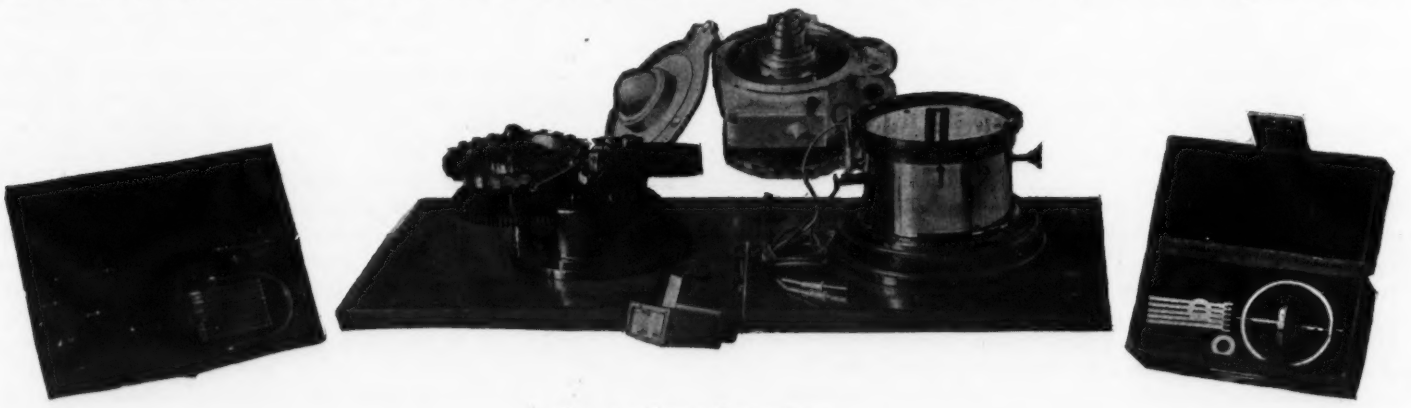


FIG. 1.—SPEED INDICATOR.

The Frahm speed indicator is based on the employment of the principle of resonance, which, as is well known, is the property elastic bodies possess of being set in vibration if they are subjected to rhythmic impulses, the frequency of which corresponds with the natural period of vibration of the bodies themselves.

Resonance may be manifested wherever wave motion occurs, as for instance with sound, light and electricity. The effects of resonance in acoustics are well known in connection with musical instruments. The fibres of Corti in the ear are an interesting example

of elastic bodies set in vibration through resonance. In the case of wireless telegraphy, electrical resonance plays an important part; and the destruction of the Suspension Bridge at Angiers on the 16th of April, 1850, by which 226 French soldiers lost their lives, was a disastrous illustration of the effect of mechanical resonance.

The investigations undertaken by Hermann Frahm on the torsional vibrations in propeller shafts (*Zeitsch. Vereins Deutscher Ingenieure,* pp. 707-880) have clearly proved that resonance in this case may have a most momentous effect. Mr. Frahm, however, did not cease his investigations when he had found means of repressing the danger of resonance, but he went further and developed the idea of usefully employing the same principle for the purpose of measuring velocities. His experiments resulted in the discovery of his present form of speed indicator.

The fundamental part of the Frahm speed indicator, which is shown in Figs. 1 and 2, consists of a spring of watch spring steel, or other elastic material, the dimensions for ordinary purposes being 40 to 55 mm. long, 3 mm. wide and 25 mm. thick. These sizes can be suitably diminished or increased in accordance with any special application.

The springs are set in a slit cut in a small rectangular shoe, to which they are firmly pinned and soldered. At its upper end each spring is bent over at right angles for about 4 mm. and the head thus formed is covered with white enamel so as to render it easily visible. In the angle which the head makes with the stem of the spring is placed a small drop of solder. The number of vibrations such a spring will make depends principally on the length of the vibrating parts and the weight at the head, as it is made of a material as uniform as possible in quality and thickness. Thus, if the springs are made so that the vibrating part is about 2 in. long and more or less solder is attached to the head, any suitable period between the limits of 35 vibrations per second and 100 vibrations per second can be obtained. The springs are screwed to a bridge consisting of an iron or brass rod and are spaced at a small distance from each other. This arrangement somewhat resembles a comb and forms a self-contained system for certain limits of measurement. The length of such a comb is, so to speak, unlimited, and it might be made to contain 100 such units of attuned springs. In most cases a comparatively small number is taken, for example, 25 to 50, while under some circumstances a much smaller number of, say, 3 to 5, is quite sufficient. This comb is fixed on two end plates of springy material, screwed to a supporting foot so as to permit the bridge to have a small vibratory movement at right angles to its axis. When only a very small number of springs are used, one such bridge is sufficient, which, under the circumstances, is fixed at one side only. In other cases this elastic support is not necessary and the comb can be placed directly on the spot where it is desired to measure the vibratory movement.

The comb can be set in vibration in various ways. The simplest of these is to place it either with or without the end plates direct on the frame of the machine, the speed of which has to be measured. As it is a matter of difficulty to keep the center of gravity of a rotating system exactly and permanently in the axis of rotation (except perhaps in the case of elastic shafts, as in the De Laval turbine), the bedplate and frame of all running machines are subjected to more or less strong vibrations. The vibrations are in many cases quite sufficient to actuate one of the springs of a comb touching the frame of the machine, and the amplitude of the vibration may reach from 2 to 30 mm., according to the eccentricity of the center of gravity.

With most machines running at a speed of over 100 r.p.m., as for instance steam turbines, Pelton wheels, fans and milk separators, to a practiced eye, accustomed to scientific work in a laboratory, an amplitude of ⅛ of an inch or even less would be sufficient for reading off the speed in the near neighborhood of the machine, when the comb is placed on it. For practical purposes, where it is necessary to stand two or three yards off the machine, so small an amplitude would be insufficient, and about 1 inch or so must be obtained. To do this it is, in most cases, necessary, except for badly fixed or irregularly running machinery, to have a special means of setting the springs in vibration.

The second and the simplest method for the production of vibration is to employ a tappet wheel or wiper. For example, such a tappet wheel with a number of elevations and depressions on its periphery is fixed on the shaft, the speed of which it is desired to measure, and works against a lever, which is thereby caused to vibrate. The vibrations can be transmitted to one of the combs above described by placing it directly on the other end of the lever, or it may be connected with the lever by means of a rod, wire or string. Should it be necessary to measure the speed of a machine at greater distances, it is better to employ *electrical* transmission. The following is one method of effecting this: On the bridge of the comb, parallel to the springs, is fixed a piece of soft iron in the form of a flat rod, which forms the armature of a magnet, on the poles of which two coils are wound. If now an alternating current is passed through these coils, the magnetic force will be alternately increased and diminished, and the armature correspondingly attracted and repelled, so that the comb is made to vibrate in correspondence therewith. All the springs will, therefore, be made to quiver slightly at their lower ends, and that particular spring whose natural period of vibration is most nearly in unison with the actuating impulses, will be set into very strong vibraton, its amplitude depending on the more or less close agreement of its natural period with that of the actuating device.

If we wish to employ this method to determine the speed of an alternator, all that is necessary is merely to connect these magnet coils through a resistance to any convenient point in the network. The speed can be then read off directly, as the frequency is a direct multiple of the speed. The device is in fact the simplest and most reliable frequency meter.

Should it be desired, however, to measure the speed of a machine which does not furnish alternating currents, we must use a special alternating-current generator, which can be driven from the machine in question. A generator of the simplest form for this purpose consists of a soft-iron toothed wheel, which rotates close to the pole pieces of a permanent magnet, on which are wound two small coils. This revolving armature may either be fixed direct to the shaft, the revolutions of which it is desired to measure, or the driving power may be transmitted from the start to the revolving inductor by means of a small belt. This apparatus may be called the transmitter (using the same terminology as in telegraphy or telephony). Its circuit is connected either by two wires or one wire and an earth return to another apparatus illustrated in Fig. 1, called a receiver, which indicates by its vibrating springs the frequency and thereby the velocity at any instant. Instead of an alternating current an interrupted current can be used to actuate the apparatus, by using any one of the well-known forms of direct-current interrupters, driven by the machine, the speed of which is to be measured.

From the foregoing it will be obvious that the vibrator which is actuated electrically may be made to serve very conveniently, determining the frequency of an alternating current, or the interruption per second of a make-and-break, direct-current circuit, and thereby determine the number of revolutions per minute of any machine or shaft at any distance either with or without a special transmitter. It will be clear also that a transmitter can simultaneously operate several receivers, as waves of different frequency and amplitude can be superimposed on each other in one conductor, but will be again analyzed in the receiver. In the same way one receiver can at one and the same time be actuated from several different places. In this way it is possible to compare the frequencies of two or more alternating currents. Frahm's indicator is especially adapted for paralleling alternators and polyphase generators, or as a phase indicator, or for the determination of the slip of an inductor motor.

The long continued practical experiments and investigations conducted by Mr. Frahm at the shipyard of Messrs. Blohm & Voss at Hamburg, where he acts as chief engineer, have demonstrated that the natural periods of the springs, and therefore the indications of the apparatus, do not vary in the least with the lapse of time, even in the case of apparatus which has been working continuously for nearly two years. Single springs, particularly those which correspond to the normal indication, have, during this period, made more than one hundred million vibrations, but they have not experienced any detrimental changes, and indicate to-day a vibration of the springs not in the least influenced by the manner in which the impulses are set up, by the strength of the movement of a tappet wheel or whether they be transmitted electrically, as we have already described. In the latter case the degree of accuracy of the indications is not in the least influenced by the resistance of the conducting wires, or the variations in voltage of the magneto generator. In fact, the accuracy depends solely on the frequency of the impulses.

In Fig. 1 the small ring lying in the gyroscope case is the mechanical transmitter or tapper wheel for the cream separator and is itself a remarkable piece of mechanical work.

An Alternating Current Relay for Low Frequencies.

BY FRANK F. FOWLE.

SEVERAL years ago the writer designed a relay for use on low-frequency, alternating-current circuits, which possessed certain novel features, and it is herewith described for the benefit of any who may care to use it. The particular problem was that of producing a relay to operate on circuits of 16⅔ cycles with a very small consumption of energy. It was found by experiment that the simple types of relays designed for direct-current circuits were inoperative, owing to armature vibration and consequent failure to maintain a closed local circuit. This difficulty had been overcome by means of spring contacts and heavy armatures, but relays embodying these features were sluggish in their action and uncertain in releasing their local contacts when adjusted to operate on small energies. These relays were universally of the single magnetic circuit type.

The force between the armature and the pole pieces of a non-polarized, single magnetic circuit relay is always one of attraction, irrespective of the direction of flow of the energizing current. If the energizing current be alternating the force will be pulsating and of double the frequency of the current. It was necessary to devise means for holding the armature while the attractive force passed through zero; and this was accomplished by adding a second magnetic circuit, energized by a separate winding, and arranged to exert a force of attraction on the common armature. A condenser was employed to so displace the phase of the current in one of the windings that the two independent attractive forces, exerted on the common armature, did not pulsate in unison, but in such a manner that one was a maximum at the moment the other was zero. That is, the condenser was arranged with the two windings in such a manner that the currents were respectively 90° out of phase with each other.

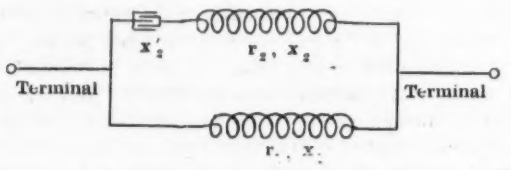


FIG. 1.—ARRANGEMENT OF CIRCUITS.

The principle may be extended to any number of separate magnetic circuits exerting forces on one armature; for n magnetic circuits, the phase of the current in one energizing winding will be $1/n$th of a half cycle ahead or behind the phase of the current in the next winding; that is, there will be n phases, differing progressively by one $2/n$th of a cycle. The total resultant armature force pulsates the least when the n forces are equal. It was found that two magnetic circuits were sufficient to reduce the armature vibration at 16⅔ cycles to a point where it could not be detected ordinarily. It is essential to note that the several magnetic circuits must be independent. The writer saw an answer to a query recently, in which it was shown how to construct an alternating-current relay; a drawing showed one magnetic circuit, embracing one armature and energized by two windings, one of the windings having associated with it a condenser for producing a phase displacement. Such an arrangement is not operative, because there will result a single magnetic flux, neglecting leakage, differing in phase from either energizing current, but in phase with their vector sum, neglecting the lag due to hysteresis and induced core currents.

The relays experimented with were of two different construction types and two circuit arrangements. One of the circuit arrangements is shown in Fig. 1. The condition for 90° phase difference between the currents in the respective branches is given in (1):

$$\frac{x_1}{r_1} = -\frac{r_2}{x_2 - x_2^1}. \qquad (1)$$

If the windings are equal the conditions are

$$r_1 = r_2 = x_1 = x_2 = \frac{x_2^1}{2}, \qquad (2)$$

resulting in equal currents in the two branches, leading 45° in one and lagging 45° in the other, with respect to the impressed e.m.f. The total impedance is equal to the resistance of one branch, and the relation between the inductance of one winding and the necessary capacity in x_2^1 is

$$LC = \frac{10^6}{8\pi^2 n^2}, \qquad (3)$$

L being in henries, C in microfarads and n being the frequency in cycles per second. At 16.7 cycles LC is 45.5.

The other circuit arrangement is shown in Fig. 2. The condition

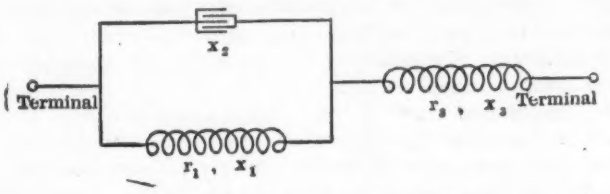


FIG. 2.—ARRANGEMENT OF CIRCUITS.

that the current in one winding shall differ 90° in phase from that in the other is given by the following expression:

$$\frac{x_1}{x_2} = 1. \qquad (4)$$

If the windings are equal and the currents in the respective windings are equal, the conditions are:

$$r_1 = x_1 = x_2 = r_2 = x_2. \qquad (5)$$

The total impedance is equal to twice the resistance of one winding, and the relation between the inductance of one winding and the necessary capacity is

$$LC = \frac{10^6}{4\pi^2 n^2}. \qquad (6)$$

At 16.7 cycles LC is 90.9.

The two designs are shown in Figs. 3 and 4. The design in Fig. 3 is the cheaper and the most readily adjusted and repaired; the design in Fig. 4, of the iron-clad tubular form, is preferable for telephone work because it may be readily sheathed with copper to prevent crosstalk between adjacent relays and is adaptable to mounting in rows on a single supporting strip. In testing the efficiency of the phasing scheme, a 12-volt lamp was arranged in series with

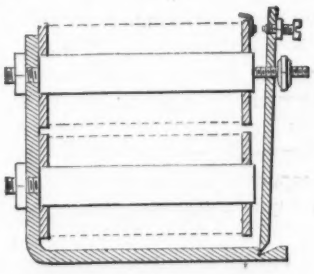


FIG. 3.—DESIGN OF RELAY.

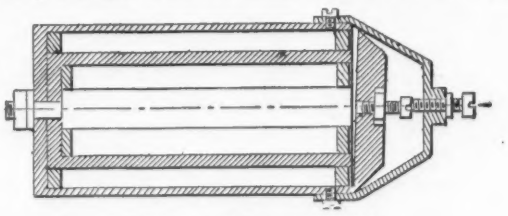


FIG. 4.—DESIGN OF RELAY.

a battery and the local contacts of the relay; the absence of flickering of the lamp was taken to indicate that the local contacts maintained a constantly closed circuit. A telephone receiver shunted by a low resistance might have answered the same purpose.

The relay in Fig. 3 consists of two parallel electromagnets, attached to a common yoke; the yoke is brought forward and slotted transversely to receive the knife-edged armature. There are two adjustments, one governing the air-gap when the relay is energized and the other governing the gap when the relay is normally de-energized; these adjustments control the maximum releasing current

and the minimum operating current, respectively. A relay having cores two inches long and windings one inch in diameter, was wound with 10,500 turns of No. 37 B. & S. gauge single silk-covered wire on each spool, the resistance being 900 ohms per spool. It could be adjusted to operate satisfactorily on 3 milliamperes with the circuit of Fig. 1, using 2 microfarads; it operated satisfactorily on 2 milliamperes with the circuit of Fig. 2, using 4 microfarads. It operated satisfactorily on these sensitive adjustments when the operating current was increased between five and ten times the above values. The tests were made at approximately 17 cycles. The rapidity of response and of release were equal to those of a direct-current relay of the same general design.

The relay in Fig. 4 consists of an iron-clad electromagnet having a second winding wound over the encasing sheath; a second and outer iron sheath makes the second winding iron clad also, and a disc armature is arranged within a brass cap on the pole end of the magnets. This relay has two adjustments similar to the former one and has the advantage of being dust-proof. A relay whose outer shell was three inches long and one and five-eighths inches (1⅝ in.) in diameter was wound with approximately 10,000 turns in each winding; the inner winding had an approximate resistance of 1,000 ohms and the outer of 2,000 ohms. Tests on this relay with both series and parallel connection of windings, using between 1 and 3 microfarads, showed it to be nearly as sensitive as the relay of Fig. 3, operating on 3 milliamperes.

The relay of Fig. 4 is preferable for use on telephone talking circuits, because its great impedance adapts it to being bridged across the circuit and because a copper cylinder over the outer shell will prevent crosstalk with adjacent relays, due to stray magnetic fields. It is customary in telephone practice to mount relays of a kind in rows of eight or ten on a strip, the relays being horizontal and parallel to each other. If the relays are connected directly to talking circuits, without intervening impedance, there is usually crosstalk between telephone circuits whose relays are adjacent, or separated by one. The induced currents in the copper sheaths effectually prevent this by de-magnetization of the external stray field. The relay of Fig. 3 is preferable for purely telegraph or signal circuits. It is adaptable to alternating-current telegraphy or to use on alternating-current track circuits in automatic block signaling.

In conclusion, the writer desires to draw attention to the fact that this device is not altogether new, although the following devices were learned of after the relays were built. Edison devised a similar arrangement to prevent the kick-off of the neutral relay in his quadruplex during the reversals of current by the pole-changing transmitter. This consisted of an auxiliary magnet, energized from the line, in series with a condenser. Jones used a similar auxiliary magnet, energized from the secondary of a transformer whose primary was in the main line. No one seems to have employed such devices with periodic alternating currents.

Discussion On Single-Phase Railway Motors.

Last week we presented an abstract of the interesting lecture by Prof. A. S. McAllister before the October meeting of the New York Electrical Society on "The Single-Phase Railway Motor," and we give below an abstract of the discussion which followed.

In introducing the discussion, President Frank J. Sprague said Prof. McAllister's remarks made it clear that what is generally sought in the development of the single-phase, alternating-current motor is a type that will run as a series motor, but that this effort is handicapped by the transformer action which takes place. He considered the single-phase motor in its present stage as a very interesting patient, hardly yet free, however, from the weaknesses and diseases which are incident to all new developments, but a good many doctors at present are working on the patient.

Mr. A. H. Armstrong said that his company even as far back as 1893 commenced to experiment with different forms of alternating motors for railway work. Two or three years ago the single-phase motor of the commutator type was again taken up and experiments renewed with low-frequency current, and a system founded upon it which has been developed to the commercial stage. The repulsion type of motor was also experimented with, and while it has qualifications that are very good, which is also true of its inverted type, it is limited to suburban work. From the operating standpoint a suburban car equipped for alternating current should be adapted to run over city lines equipped for direct current. The repulsion motor as such cannot run with direct current. It can be converted by certain changes and connections into the series type of direct-current motor, but the complications involved are such as to render it inferior in this respect to the simple type of alternating series motor. The compensated series motor has been developed largely for suburban work to meet the demands imposed by alternating current outside of a city and direct current in a city. The repulsion motor, moreover, is not quite as efficient as the compensated series type. It may have a certain field in the future for heavy freight service, as it has a more even and slower speed than the single-phase compensating type.

In introducing Mr. C. F. Scott, President Sprague said that as far back as 1884, while experimenting with a small direct-current motor built for stationary purposes, he suggested that it would run on an alternating-current circuit. This was true if the alternating current was of low enough frequency, but lamination of the fields was one of the first steps necessary to make operation possible. Mr. Sprague referred to some early trials of motors for elevated railway service, at which the late Jay Gould was present. The motors were mounted on a long platform car and when run at a fair speed the motors were suddenly reversed. A lead safety catch had been inserted in the circuit in plain view on the car platform, and upon reversal this let go with a vicious arc, whereupon Mr. Gould turned and started to run off the car, but was prevented by Mr. E. H. Johnson. Mr. Sprague added that the influence of Mr. Gould's opinion as to the practicability of electric railways may be judged by the fact that he never saw any of the experiments which were conducted for some months on the Thirty-fourth Street branch of his road.

Mr. C. F. Scott said that in 1888 when he was associated with Mr. Tesla, an induction motor was designed for railway work and several were built and mounted on a truck. When, however, current was thrown on, the motors gave a low growl and a slow speed and did not seem to be inclined to do more than work very hard and very slow. A year or so later motors were made having multiple poles, some having 8 or 12 poles, but they were not found suitable for railway work. Several years later the series motor was tried under the direction of Mr. Lamme, but there were some things which were not understood and the results on the whole were not successful as leading on to commercial work, although the motors were mounted on a car and the car was actually run. The matter was then held in abeyance until some three or four years ago, when it was taken up actively, and three years ago an experimental equipment was made and put to regular commercial work. The motor in this case was of the compensating type, in which the auxiliary coil was short-circuited on itself. Shortly afterward Mr. Lamme found that on the whole the compensating type, with all coils in series, seemed to be the best. Mr. Scott said it is rather singular that out of all the different combinations of transformer and motor and the like, the one which has been finally selected by the different companies during the past several years approximates most nearly to Mr. Sprague's old simple series motor. He said that the Westinghouse Company has now under construction in its factory orders for customers for different roads for a total of 186 single-phase railway motors of varying size, having a total capacity of 114,000 hp. The sizes range from 50 to 150 hp. The maximum speed on the roads now being equipped is 60 miles per hour; the interurban trolley voltage ranges from 1,100 to 3,300 alternating, and for city work from 400 to 700 volts direct current. The weights of the cars range from 25 to 50 tons, including electrical equipment, and the various roads have a total of about 200 miles of line. The longest of these roads is one from Indianapolis to Cincinnati, 57 miles, which will probably be extended later to about double that distance. The motors for this line are of 300 hp capacity. There will be no difficulty in building motors up to 400 hp for railway service.

The series alternating-current motor does not in a general way materially differ from the direct-current motor. It has the same general characteristics and general form, and in weight and appearance it is about the same thing. The advent of the new type of motor, however, will have a revolutionary effect. The higher trolley voltage and the higher insulation for the trolley wire will lead to a new type of overhead construction, and feed wires will be done away with. There is likely also to be a change in the method of control, the contact controller and rheostat disappearing. Direct-current motors may be made for 700 volts with two in series, the trolley supplying 1,200 to 1,500 volts. One of the weak points of

this system, however, would be the insulation of the motor winding from the ground, since the winding will have between its copper and its iron this maximum voltage of 1,200 to 1,500 volts. With the alternating-current motor this objection is removed, because if the trolley voltage were even 10,000 a transformer would transform it to a low voltage for the motor, usually 250 volts. Moreover, a short-circuit in the alternating-current system would not, like in the direct-current system, give rise to flashes tending to increase liability to damage.

Mr. Henry A. Lardner said that the single-phase series motor seems to be an almost perfect apparatus. There is every reason why this should be so, since the motor is wound for only 250 volts, and it has the advantage of all the experience gained in the design of the direct-current motor during many years. Referring to the matter of sub-stations, he said that it should not be lost sight of that attendants at sub-stations are frequently utilized to sell tickets, take care of an express business and do many things besides attending to the rotary converters. If single-phase motors were adopted and the rotaries eliminated, in a great many cases it would be necessary to retain the former attendant. As to first cost, there are some items that would be more expensive than with the direct-current system. First of all, the equipments are higher in first cost, there are a number of pieces of auxiliary apparatus which must go on the car, such as the transformer to reduce the trolley pressure to 250 volts and a number of other items. These add practically 25 per cent. to the weight of the motors and an additional cost is to be expected. The increased resistance of the rail to alternating current and the increased impedance of the circuit tend to counterbalance the saving due to increased trolley pressure to a surprisingly large extent. The principal danger in the use of the higher voltage will be to people who come in contact with the tracks or grounded hand rails when the car runs on sand or snow and is thereby insulated from the track. Mr. Lardner cited a case of an accident resulting in death on a three-phase locomotive operating at about 1,700 volts, through a man coming in contact with some part of the track when the locomotive was insulated by sand on the track. A remedy for this danger suggested is to insulate the hand rails and other metallic portions of the car.

Mr. Lardner referred to the poor power factor of alternating-current railway systems. If the drop in an alternating-current road is calculated it will be found to be very excessive unless a good deal of feeder wire is provided. Provision must be made, not only for the drop between the cars and the sub-stations, but it must be unusually small to make up for uncompensated lack of regulation in the step-up and step-down transformer, in the high-tension transmission and in the generator when operated under a poor power factor. He said that all these points make it extremely desirable to have a motor which approximates unity power factor or even goes beyond that and helps to overcome the reactance of other parts of the system. Mr. Lardner said that Prof. McAllister is working to this end and he wished him success.

President Sprague, in introducing the final speaker of the evening, Mr. C. O. Mailloux, stated that at the recent International Electrical Congress he called attention to the possibility of danger by the introduction of high-tension wires into a car, contact being possible when the insulation deteriorated and the metal framework of the car was brought into potential relation with the incoming wire. At such time a passenger standing on the ground and grasping a hand-rail would receive a fatal shock if the car wheels were kept from contact with the rail by an abnormal amount of sleet or sand. This is a danger to which those who equip roads with alternating current of high potential must give every possible heed. One thing not referred to by the speakers, which militates against the alternating-current equipment, is the increased charge for operating because of the additional weight of the alternating equipment, which charge will be continuous.

In opening his remarks, Mr. C. O. Mailloux said that all the speakers had dwelt upon the fact that the best single-phase, alternating-current motor is practically a series motor of the direct-current type, with such slight modifications as are necessary to adapt it to an alternating-current circuit. The most interesting practical results thus far obtained are, however, to be credited to the Winter-Eichberg and Latour types of motors, which differ from the above. In the Winter-Eichberg motor the compensating field is obtained by placing two brushes (called exciting circuit brushes) at different points of the armature commutator and by applying a suitable e.m.f. at these points to send current into the armature winding, this e.m.f. being obtained by some kind of transformer action. They also utilize the transformer action of the armature winding to produce the field magnetism. With this system it is necessary to have so-called "short-circuit brushes" as in the case of the repulsion motor, there being two sets of brushes, one serving to send current in the armature and the other serving to let current come from it at certain points situated half way between the other brushes, in order that the compensating and reactive effect desired may be the resultant action of the two. This motor can be made to give the characteristics of an ordinary direct-current series motor, and can also be made just as easily to give the characteristics of a shunt-wound, direct-current motor. It is controlled entirely and very simply by merely varying the excitation current applied to the armature from an external source. For a series motor characteristic a potential transformer giving a variable e.m.f. is used, and for a shunt motor characteristic a current transformer has to be used. It is a relatively simple matter to make such a motor operate like a shunt motor at will and consequently to return energy to the line on down grades or when stopping the train.

Mr. Mailloux described the system as operated on a short road near Berlin, where it was put in service in June, 1903. At the end of the year of probation agreed upon the equipment was accepted, and is now being operated by the German Government. The motor cars weigh empty 52 tons and the trailer cars each 12 tons. A train, therefore, of two motor cars and three trailers weighs empty about 140 tons, and loaded about 160 tons. Each motor car is equipped with two Winter-Eichberg motors, each of 100 hp. The motors are four-pole, weighing about 1,200 kg. The cars are geared for a maximum speed of 60 km. and a normal speed of 40 to 45 km. per hour. The trolley line potential is 6,000 volts and the frequency 25 p.p.s. The field winding is designed for the full line potential. When the motor is in circuit it is connected between the trolley line and the rails as if it were the stator of an induction motor or the shunt winding of a direct-current motor. The potential applied at the armature varies from 19 to 190 volts, the e.m.f. regulation being obtained by taps from the secondary of a transformer which steps down the voltage from 6,000 to 190, to furnish current for an exciting circuit and also for an air compressor motor for the control circuits. A multiple-unit control system is used which is outwardly much the same as the Sprague multiple-unit control system. The trolley line is of the catenary type, the trolley conductor being supported by a steel catenary wire by means of small vertical support wires, the whole suggesting a miniature Brooklyn Bridge. The copper trolley wire is not subjected to much strain, the catenary and suspension wires being depended upon to hold it in place. At some places there are two catenary or suspension wires serving to support the trolley conductor, the object of the double suspension being to steady the trolley conductor and prevent lateral movement. In acceleration the lowest readings observed were about 20 and the highest about 30 amp., the current at full speed ranging from 15 to 20 amp. The lowest value of power factor during acceleration was about .80, the average value being from .82 to .86, the power factor becoming practically at unity at full speed. The normal acceleration is about ,97 ft. per second, but has been increased in tests to more than double this per second. Dr. Eichberg has stated that the energy consumption is slightly lower with alternating current than with direct current, the actual figures being 41 watt-hours per ton-km. with a power factor of 82.3 in the case of a train propelled by single-phase motors, and 43.6 watt-hours per ton-km. in the case of a train propelled by direct-current motors, the average velocity being 34.4 km. per hour. The motor commutators are examined about every month and it has been found that they can be kept in satisfactory condition by sandpapering every five to seven weeks.

Another line operated with the same motors is at Stubaithal, in the Austrian Tyrol, the length being about 18.5 km. The road runs up a mountain grade of about 2.5 per cent., with portions having a grade of 4.5 per cent. The line potential is 3,000 volts, but it is intended that the cars shall run in the streets of Innsbruck and the field winding has been designed for a potential varying from 450 to 525 volts. This will be the voltage of the street line, and the 3,000-volt current will be reduced to this by means of a transformer placed in the motor car. The trolley line in this case is also of the catenary type. The motor cars weigh 19.6 tons and have a capacity for 40 passengers seated and 20 passengers standing. Each car can draw two trailers, each weighing 6.7 tons and about 10 tons loaded. The motor cars are each equipped with two motors of 40 hp each. The two field windings in this case are connected in multiple and the two

rotors are connected in series. Both the stators and rotors derive a current supply from the secondary of a transformer which gives two voltages, namely, 500 volts between terminals and 400 volts between one terminal and a tap in the winding. The e.m.f. in the exciting circuit is regulated by a reactance having four taps connected with the controller. The lower voltage, 400 volts, is used for starting and running at low and moderate speeds, and the higher valtage, 500 volts, is used for the highest speeds. The object of putting the transformer secondary between the trolley line and the rails when running in the city streets is to utilize this secondary winding as an auto-trasformer so that the intermediate potential of 400 volts will then be available just as when running on the high-potential line. The highest speed allowed is 25 km. per hour, and the frequency is 42 p.p.s. At first very thin brushes were used, but these have been gradually increased to 3/16 in. Since the short-circuit brushes have to carry much stronger currents than the exciter currents, there are four sets of the former and only two sets of exciter brushes. Dr. Eichberg has stated that the motor can be designed for 40 or 50 periods as well as for low frequencies. He prefers to have the gearing ratio so arranged that the maximum motor speed will be about 30 per cent. above synchronous speed. In this way the average speed for the entire time that the motor is running will be near synchronous speed and the power factor will have the highest average value.

Mr. Mailloux next referred to the Latour system. Several motors of this system have been built and installed by the French Thomson-Houston Company for stationary purposes. Mr. Mailloux said that the performance of these motors, which he saw in operation, was such as to command the warmest admiration. Three of them form the equipment of a traveling bridge and crane serving to handle large blocks of building material. They quickly come to a standstill, reverse and as quickly gain speed in the other direction without the appearance or suggestion of a spark at the commutator, whose appearance would compare favorably with that of any direct-current commutator which had been in service an equal length of time. The largest of these motors was of 25 hp.

Mr. Mailloux then described the system now under experiment by the Oerlikon Company in Switzerland with a view to securing its adoption on the steam roads in Switzerland, which are shortly all to be electrified. The experiments are being conducted on a line about 20 km. long, the voltage employed being 15,000. The electric locomotive is equipped according to the Ward Leonard system, the car motors being direct current supplied from a motor-generator operated by a single-phase synchronous motor, the frequency of the current being 15 p.p.s. The direct-current generator being driven by a synchronous motor necessarily runs at constant speed. The speed regulation of the car is accomplished by varying the field excitation of the generator, thus varying the e.m.f. at the motor terminals. One of the most interesting parts of the equipment is the current-collecting system. The trolley conductor is disposed at the side of the track and at a relatively low elevation at all portions except when passing through tunnels. The trolley is replaced by a contact arm consisting of a short piece of metal tube hinged at one end to a support attached to the roof of the locomotive and projecting laterally; a spring causes it to bear against the contact line and rub against it as the locomotive moves. At all points except near and in tunnels, the contact arm comes down over the contact wire and bears directly down on it. One of the advantages of this is that in cold weather the line contact continues perfect, even while icicles are hanging from the under side of the contact wire. As the contact wire approaches a tunnel it gradually arises and takes a position over it and over the train. The upper end of the hinged contact arm is thus forced upward, with a result that the contact is gradually shifted from the top to the side of the contact wire until finally as the locomotive enters a tunnel the contact wire is above the car and the contact arm is bearing against its lower surface, just like an ordinary bow trolley. The average height of a contact wire outside of a tunnel is 14.8 ft. and 16.4 ft. in tunnels. The poles consist of old iron rails set in the ground about 5 ft. deep, sometimes with a footing of concrete. The distances between poles vary from 80 to 110 ft. and in some cases may be as much as 135 ft. The insulator is mounted on a very simple cup-shaped support attached to the upper end of the rail. The entire cost of the line equipment for this system, including poles, contact wires, section switches, laps at sections and at stations and auxiliaries of all kinds, is about $2,400. The estimated drop over the line will not exceed 500 volts or 3⅓ per cent. In many cases the feeder line and contact wire will be the same.

Mr. Mailloux said that the estimates of cost and equipment of the St. Gothard tunnel line by the Huber system showed clearly that electrical operation would pay and pay well. The estimated saving in cost of operation was equal to over 10 per cent. on the total capital equipment when the cost of electrification was included and over 15 per cent. on the present capital investment. Mr. Mailloux said he considered the Huber system to be one of the most promising recent developments in electric traction methods instituted for steam roads, and one having possibilities bringing us much nearer to success than we were before. He cannot help feeling that some such method as that of Mr. Huber will have to be used for conveying current to the electric locomotive or motor cars when we attempt to utilize potentials of 10,000 volts and over.

In concluding his remarks, Mr. Mailloux pointed out that a series motor supplied with single-phase current would not utilize as great a portion of track adhesion as a direct-current motor. In the first place, there is a difference between the average torque for an entire current cycle and the maximum instantaneous value of the torque obtained at some particular instant during that period. The tendency to make a wheel slip on the track will depend on the maximum instantaneous value of the torque, whereas the actual drawbar pull depends on the average or mean torque. The consequence of this is that a single-phase motor would have less maximum starting torque than a direct-current motor of the same rating. For locomotives of the same weight, the wheels of one equipped with alternating-current motors should begin to slip with an average drawbar pull equal to about 50 per cent. or not over 55 or 60 per cent. of the drawbar pull obtainable with direct-current motors. Experiments made by Ganz & Co. have confirmed these figures. Later experiments made by Major Cardew, of London, show, however, that while this phenomenon undoubtedly occurs with frequencies under 15 p.p.s., it disappears at higher frequencies and it is not observable with frequencies of 25 or more.

New Telephone Patents.

PRIVATE BRANCH EXCHANGE FOR RESTRICTED SERVICE.

It sometimes happens that in an establishment having a private branch switchboard it is desired that only a certain prescribed number of the local sub-stations be permitted to talk through the main central office, the remaining stations being restricted to service local to the precincts of the subscriber's establishment. In such cases the care and honesty of the operator of the private switchboard has usually been relied upon to properly restrict the service. To eliminate any error due to carelessness, Mr. J. L. McQuarrie has invented a circuit scheme for private branch switchboards, which renders it impossible for the operator to inadvertently misconnect the stations. This is accomplished by carrying each central office line through the contacts of a cut-off relay, which is so connected to the trunk jack that it becomes energized if a cord pair be simultaneously connected to this jack and the jack of a restricted station.

CALL COUNTER FOR AUTOMATIC SWITCHBOARDS.

One would naturally think that the number of calls sent over an automatic exchange such as is installed in some of the central and western cities would be of little moment to any one. The cost of current per call to operate the exchange must certainly be insignificant and certainly the cost of service otherwise must be nearly constant irrespective of the number of good connections. Nevertheless, a connection counter for automatic exchanges has been developed and patented. This counter is arranged to count only good or completed connections, making no record of any calls defeated by busy apparatus. The proper operation of the counter is based upon the fact that a definite number of current impulses is necessary for each properly completed connection, each of these corresponding to movements of the exchange mechanism and serving to advance the counter a proportional part of one count. When a call fails one or more of the impulses are omitted. In this case the motive part of the counter fails to advance the dial a complete step and, as the switching mechanism is returned to the normal position, the partial count is deducted by a spring acting on the dial shaft. The deduction of whole counts is prevented by suitable rachet devices. The

inventor of this device is J. Erickson, of Chicago, he having assigned his patent to the Strowger Automatic Telephone Exchange.

COMMON BATTERY SWITCHBOARD CIRCUITS.

Three rather simple lamp signal, common battery circuit systems form the respective subjects of three recent patents. Two of these are granted to F. R. McBerty, of Evanston, Ill., and one to C. E. Scribner, of Chicago, all three patents being assigned to the Western Electric Company. All three systems depend upon mutual shunting effect of the lamps, one upon the other, for the proper signal display.

Scribner's system is shown at the top of Fig. 1. In this system a removal of the receiver from the hook closes the circuit of the windings, *b b'*, connected, to be cumulative in their effects. The relay contact closing causes the line lamp, *f*, to receive sufficient current to glow. Upon the response of the operator, the supervisory, *K*, is placed in shunt with *f*, the combined resistance of the two lamps being so small in comparison with resistance, *e*, that neither will glow. When the relay contact breaks, lamp *k* receives its normal current, the circuit of *f* being broken. Lamp *k* under this condition glows. A distinct novelty lies in the arrangement of the talking circuit in this system. It will be seen that the connection circuit between the lines is entirely local. The winding, b^2, serving as the secondary of a repeating coil, of which *b* and *b'* are the primaries.

A modified signal scheme, that of one of McBerty's systems, is indicated in the middle of Fig. 1. The relay shown is supplied with battery and is included in one side of the circuit extending to the subscriber's station. The parts, *h* and *g*, indicate respectively the parts of the line jack and plug included in the signal circuit, while the cross, 5, indicates a plug socket switch. The call of the sub-

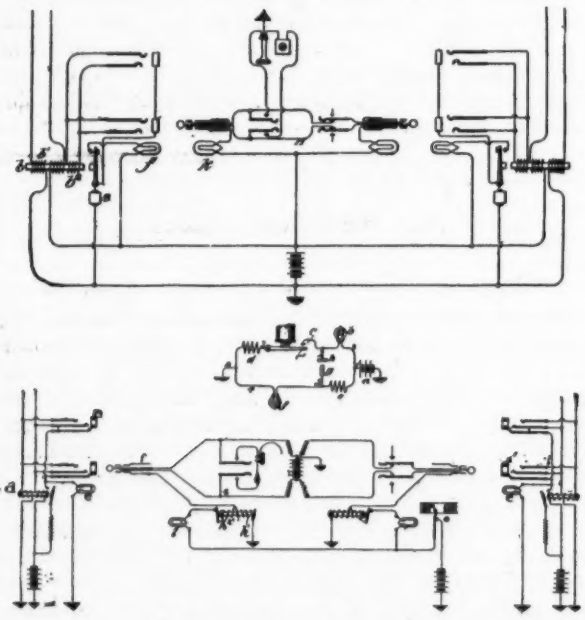


FIG. 1.—SCRIBNER SWITCHBOARD CIRCUITS.

scriber is indicated by the glowing of lamp *b*, in response to the closure of contact, *c c'*. When the plug is lifted from its socket by the operator, 5 closes its contact and then the contact *g h;* that of the plug with the jack immediately follows. With these connections the circuit, *e, g, h, c, d,* deprives the lamps of too much current for either to glow. When *c c'* opens, upon the depression of the hook switch at the subscriber's station, the lamp, *f*, receives its normal current, its shunt, *d*, being removed.

In the lower part of Fig. 1 is shown the second arrangement of Mr. McBerty. In this case the response of relay *d* to current completes the circuit of line lamp *c*. The insertion of plug *f* in the jack places coil *h'* of the supervisory relay in parallel connection with *f*, shunting this out and at the same time pulling up the armature of relay h' h^2. When current is supplied to the supervisory lamp following the removal of the calling plug from its socket, the lamp, *l*, fails, its circuit being open. When relay, *d*, drops back, thereby releasing relay h' h^2, the lamp, *l*, glows. It might seem at first thought that this latter relay will chatter, having its contact in series with its coil This effect is avoided, however, as windings *h'* and h^2 are in differential relation and cancel each other's magnetic effects.

Another common battery system has been patented by H. T. Cedergren, of Stockholm, Sweden. This system requires a master relay and an auxiliary relay in each line circuit plug socket switches, as well as the usual supervisory relays in the cord circuits. While the circuits are quite novel, the features are not such as to warrant any detailed description in this connection.

CUT-OUT FOR RURAL TELEPHONES.

Fig. 2 shows a sectional view of a cut-out for rural telephones, a patent for which has been granted to R. E. Pedigo, of Lucas, Iowa. The left-hand metal plate is grounded and presented to its serrated edge is the edge of the middle plate, or instrument plate. The line plate also has a serrated edge which is opposed to an edge of the middle plate. Over all is arranged a knife switch so arranged as

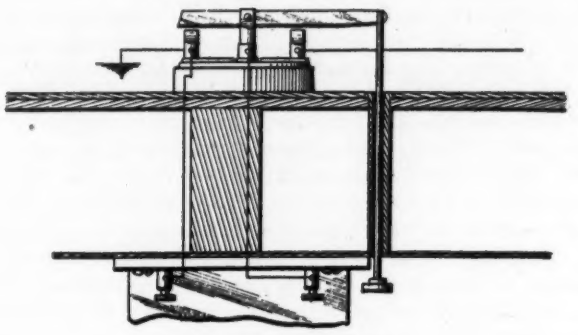


FIG. 2.—PEDIGO CUT-OUT.

either to short-circuit the instrument and serve the line connection or to close the connection to line and at the same time open the shunt about the instrument. This latter is the normal condition of affairs.

RECEIVER SUPPORT.

Another receiver support has appeared, this the invention of Messrs. H. A. Barnes and N. E. Showacre, of Baltimore. The chief features are a spring attachment of the receiver to its support, to provide some flexibility, and a rack and pinion mechanism to control the hook switch in adjusting the transmitter and receiver to the proper height.

AUTOMATIC EXCHANGES.

Two patents relating to automatic exchanges have recently been granted to A. M. Bullard, of New York City, and L. A. Falk, of Boston. One of these patents describes improvements in an automatic exchange system, a patent for which was granted in September, 1902, to Messrs. Bullard and M. C. Rorty. This earlier system was described quite fully in these columns. The improvements all tend to simplification of the process of selecting and ringing and the rendering of the operation more sure.

The second patent describes a new system suitable for a very few lines, the apparatus being reduced to a minimum. The usual step-by-step mechanism is required, this serving to rotate a selecting arm across terminals of the lines. The number of steps given this arm depends upon the number of momentary depressions of a selecting key at the sub-station. Ringing is similarly controlled by a ringing key, each depression corresponding to one ringing of the bells. Messrs. Bullard and Falk have assigned both their patents to the American Telephone & Telegraph Company.

INDUCTIVE CABLE.

An inductive cable for special transmission work is diagrammatically shown in Fig. 3. The inductive coils are long and narrow and have closed magnetic circuits. They are built up in the core of the

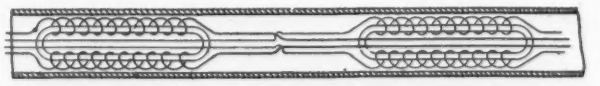


FIG. 3.—SCHLEIFENBAUM AND SCHÜRER CABLE.

cable, the coils of different pairs of wires following each other in regular sequence. Messrs. F. Schleifenbaum and E. Schürer, of Germany, are the inventors.

INDUCTION COIL FOR DUPLEX TRANSMITTER.

Mr. A. L. Parcelle, of Boston, has patented further details of his transmitting apparatus. This comprises a duplex transmitter, the

two microphonic cells of which are arranged to give opposite resistance effects, and a special induction coil. This latter comprises two primaries, each in circuit with its own microphonic button. Each primary has its own U-shaped core. The bows of the U's are placed side by side and covered by a single secondary coil. With this arrangement the primary lines of force linked with the secondary coil are given an actual reversal at each vibration of the diaphragm; for as the current and magnetization in one primary diminishes, those of the other primary increase, but of the opposite sign.

CURRENT NEWS AND NOTES.

AUTOMOBILE EXPOSITION.—The seventh international automobile show of the Automobile Club of France will be given in the Grand Palace on the Champs Elysees, Paris, from December 9 to 25, inclusive. A very large exhibit is already assured.

CONVENTION OF INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.—The next annual convention of the Interstate Independent Telephone Association of America will be held at the Auditorium Hotel, Chicago, December 13, 14 and 15, 1904. A very complete and attractive programme has been arranged and a large attendance is looked for. Mr. E. M. Coleman, Louisville, Ky., is secretary of the association.

A. I. E. E. MEETING.—The 191st meeting of the American Institute of Electrical Engineers will be held at 8.15 p.m., Friday, November 25, in the Chapter Room, Carnegie Hall, No. 154 West Fifty-seventh Street, New York. The following paper will be presented and discussed: "Problems of Electric Traction on the Long Island Railroad," by O. S. Lyford, Jr., electrical engineer, Westinghouse, Church, Kerr & Co., New York.

CABLE RATE WAR IN ALASKA.—A rate war in cable tolls has begun between the Dominion Telegraph Company, controlling land lines between Dawson and other points in the Northwest Territory, and the Seattle-Valdez cable system, for the purpose of gaining the business between the United States and Alaskan points. At present the Valdez cable is out of commission, owing to a break, and the prices of messages between Seattle and Alaska have been nearly doubled by the Dominion Company.

EXTENSIVE ELECTRIC TRACTION.—The New York, New Haven & Hartford Railroad Company began work this week on its new proposed six-track electric rapid transit system from New Rochelle to the Harlem River. The company intends to spend $15,000,000 on improvements. Property has been purchased east of the tracks at New Rochelle, where a $100,000 station will be erected. Already the work of constructing a subway under the tracks has been begun, so that passengers will be able to reach either station without climbing the steps to the high bridge over the tracks. Three hundred men will be put to work at first in starting the many improvements intended. A corps of engineers, surveyors and contractors who will be in charge of the work have opened offices at New Rochelle.

TRANSACTIONS OF THE INTERNATIONAL ELECTRICAL CONGRESS.—The *Transactions* of the International Electrical Congress are now being prepared for the press and will contain 153 specially invited papers, together with the discussions thereon at St. Louis, and a report of the proceedings of the Chamber of Delegates. They will form three large octavo volumes in paper covers, each of which will contain about 900 pages, and frontispiece engravings, two frontispieces being group photographic views and the third a view of the Electricity Building at the Exposition. The membership roll of the Congress closed on the last day of the meeting, September 17, but anyone desiring to obtain a copy of the *Transactions* can do so by subscription. Subscriptions will be received until December 1. The subscription price is $10, which includes the cost of delivery to the subscriber. As it is not intended to print a reserve stock, but only sufficient copies for the Congress membership and subscribers, orders should be sent in promptly to the treasurer, 114 Liberty Street, New York City. The volumes will constitute a valuable landmark in the literature of electrical science and engineering.

ELECTRIC TRAIN OPERATION on the New York suburban service of the Erie Railroad has been given considerable prominence in local newspapers lately, but as a matter of fact nothing has yet been done in the way of preparing plans for such service. It is well known that among the improvements which the officials of the company have in mind is a reconstruction of some nature of the Jersey City terminal arrangements. The suburban traffic of the road which centers at that terminal is capable of much development, and it is manifest that the electrical operation of the trains on the suburban lines must be considered in planning any improvements of this nature. This self-evident fact has been pointed out by Mr. J. M. Graham, fourth vice-president of the company, and probably gave rise to the report that plans for electric equipment are being considered. There is no doubt that the Erie will, however, soon come to electric traction.

STANDARD TIME.—Advices from Washington, D. C., are as follows: "The Naval Observatory will make an effort to send time signals of the new year around the world. Last year the instant which marked the beginning of the new year was transmitted over 300,000 miles of telegraph and cable wires, reaching nearly every important point, even the interior of Alaska. This year it will be sent out at midnight on December 31, and at 1, 2 and 3 o'clock a.m., 75th meridian time, to announce the exact instant of the beginning of the new year to each of the great standard time belts of the United States. It has also been proposed that at the session of the International Railway Congress, in Washington, in May next, the observatory send out to the world, as far as telegraph and cable will carry them, a special series of time signals in celebration of the meeting. The authorities at the Naval Observatory also intend to collect information relating to the kind of time in actual use in the various countries of the world."

WIRE DAMAGE BY STORM.—A great storm swept over the country on Sunday, November 13, doing great damage, particularly to telegraph and telephone and other electric wires. In Wall Street business was more hampered than it has been at any time since the great blizzard of 1888. In many offices not a quotation outside of New York and London had been received up to 10.30 a.m. Monday. Utter paralysis of wires was the complaint of the telegraph companies. The Cotton Exchange houses were without figures from the South and a chaotic state prevailed generally among brokers. The Western Union and Postal Telegraph Companies accepted business to Washington, Baltimore and Chicago, subject to delay. There were no long-distance telephone connections working to Baltimore, Washington and Chicago, but Philadelphia could be reached by telephone connection. Communication with the West was not re-established until after 3 a.m. Monday by the Associated Press. This was accomplished through a telephone wire between Baltimore and Chicago. Morse telegraph instruments were installed instead of telephonic devices, and a restricted service was begun.

TESTING MAGNETIC QUALITIES OF MATERIALS.—An improved form of ballistic galvanometer whose throw is registered with the pointer at rest, in distinction to the ordinary galvanometer whose throw is observed when the pointer has reached the maximum deflection in an oscillating movement, is the subject of a patent issued November 1 to Mr. Frank Holden. In construction the movable coil and permanent magnets are similar to those used in the Weston direct-current instruments, the coil, however, forming a locally closed circuit without connection to any external conductor. The sample of iron, the magnetism in which it is desired to measure, is interlinked with the movable coil. Any change in flux in the test sample causes the generation of an e.m.f. in the movable coil, and the current which is thus produced in the locally closed circuit gives motion to the coil in the constant field from the permanent magnets. The counter e.m.f. thus generated, being more or less equal to the active e.m.f., the coil will move to a position so as to cut in a number of lines from the permanent magnets equal to those cut out from the test sample. The initial and final positions of the coil being noted, the change in flux in the sample is readily determined.

SUBWAY HONORS.—At the last meeting of the New York Chamber of Commerce a report of the special committee on recognition of the services to the city of the Rapid Transit Commission that gold medals similar to the one presented to the late Abram S. Hewitt be struck and presented to A. E. Orr and other members of the Chamber who had assisted in the work was adopted. It was also recommended that an oil painting of the members of the Chamber who had participated in the work be made as a permanent recognition of their work, the painting to be a decoration for the walls of the Chamber as a companion piece to the Atlantic cable picture.

VARIABLE-SPEED POLYPHASE MOTOR.—In order to render polyphase motors suitable for the direct driving of tools and similar work, Mr. C. Wüst-Kunz, in accordance with a patent issued November 1, would mount upon a common shaft the rotors of three motors whose primaries are wound for different numbers of poles. One element has four poles, a second has six poles and a third has eight poles, capable of being connected to produce in effect a four-pole element to be operated in parallel with element number one. The secondary windings are permanently connected in parallel, so that additional resistance may be inserted for obtaining intermediate speeds and for the purpose of initially placing the set in operation from zero speed.

SYNCHRONIZING DEVICE.—A patent issued November 1 to Louis C. Marburg, Schenectady, N. Y., relates to means for determining phase identity of two alternating-current machines being synchronized, by employing an incandescent lamp operated at full brilliancy instead of at complete darkness, as has been the usual practice until recently. For this purpose to the circuits of each machine is connected the primary of a step-down transformer, the middle point of the secondaries of which is connected to earth. One lead from each transformer is in contact with a terminal of the synchronizing lamp, which burns at full incandescence when phase identity occurs. With this system it is easy to estimate the exact instant when synchronism occurs, while a broken lamp or defective connection is readily detected.

ALTERNATING-CURRENT VACUUM TUBE EXCITER.—In order to obtain unidirectional current for exciting Röntgen ray and similar tubes when only an alternating-current source of supply is available, Mr. Hermann Lemp employs and describes in a recent patent an air-insulated current interrupter which allows the circuit to be complete during only the period of maximum half wave of the desired polarity. The interrupter is driven at constant speed by a single-phase synchronous motor, which is connected across the primary mains. The tube is excited by the synchronously interrupted unidirectional current obtained at between 100,000 and 150,000 volts from the secondary of a step-up transformer connected to the same supply mains. The inventor employs the familiar water rheostat for controlling the current sent through the tube.

BUREAU OF STANDARDS BULLETIN.—The first issue has appeared of the *Bulletin* of the Bureau of Standards, which promises to make a most valuable addition to American scientific periodical literature. The announcement states that the *Bulletin* will embody the results of the investigations, researches and other work of the National Bureau of Standards, which may be of importance to the scientific, technical and manufacturing interests of the country. Following is a list of the contents of the first issue: "Recomparison of the United States Prototype Meter," by L. A. Fischer; "A Study of the Silver Voltameter," by K. E. Guthe, who is also the author of another paper entitled, "On Fibres Resembling Quartz in their Elastic Properties"; "The So-called International Electrical Units," a reprint of a paper read by Dr. F. A. Wolff, Jr., before the recent International Electrical Congress, with an appendix added giving the acts of various countries legalizing electrical units; "The Spectra of Mixed Gases," by P. G. Nutting, who contributes a second paper entitled "Some New Rectifying Effects in Conducting Gases." The final paper, "On the Temperature of the Arc," is contributed by C. W. Waidner and G. K. Burgess. The number comprises 124 quarto pages and a number of half-tone plates. The *Bulletin* will be issued at intervals as frequently as the number of papers ready for publication may require.

LETTER TO THE EDITORS.

The Metric Controversy.

To the Editors of Electrical World and Engineer:

SIRS:—I have been reading with interest both Mr. Halsey's book and the reviews of it which you published in a recent issue. As an engineer familiar practically with both English and metric systems, and working with equal facility in either, I cannot for the life of me see why the simple proposition to use the metric system in Government transactions after two or three years' notice should be the cause of so furious a pother. One would suppose that the possession of a foot rule were to be made a felony to judge by the rumpus that has been stirred up. One cannot help thinking that the gentlemen who object so violently to the metric system are practically entirely unfamiliar with its use, and influenced rather by a Chauvinistic hatred of measures introduced by the frog-eating Frenchmen than by any sober consideration of the merits of the question.

The often-repeated assertion that the foot, inch and pound are "natural" units; that all peoples in all times have "instinctively" settled upon such lengths and weights, and that it is "artificial" to subdivide them save on a binary, duodecimal or some other system, are historically wide of the mark and merely amount to a realization that English measures are (unfortunately) not upon a decimal basis. The fact is that precise measurements of any kind belong only to very recent times, and what savage tribes did or did not do in the dawn of civilization, is not to-day of the slightest consequence. In point of fact, the decimal system dates back to very early times like the others, and the whole civilized world to-day, however it may vary its weights and measures, bases its computations upon a decimal notation.

Our English weights and measures are disconnected survivors of mediæval times when an inch was the length of three barley corns, and the fathom the span of somebody's outstretched arms. Their preservation in use is really a matter of no general consequence, and they do not represent any coherent or intrinsically valuable system. Our foot starts in with a duodecimal subdivision, but the line and the point have fallen out of use, and in practice the inch goes down to 32nds, or more rarely to 64ths, in binary subdivisions and then passes to decimals. It has to do so for convenience in computing by our Arabic notation. Fancy the consternation of a machinist given dimensions in 5/12ths of an inch or starting to compute with a slide rule the weight of a block, say, 5 11/32 x 6 17/64 x 16 15/16 in.

The most curious error into which the anti-metric advocates have fallen is the tacit or expressed assumption that because meters and feet are connected by a rather complicated numerical relation, common lengths after the adoption of the metric system would have to be expressed in long rows of decimals. This point of view merely indicates utter ignorance of practical affairs. It is perfectly true that 5 13/32 in. is not an integral number of millimeters, but it comes so near it that the difference is not of the slightest consequence in 999 cases out of 1,000, and the first decimal place would settle the remaining case. In other words, the measurements of ordinary life are not exact enough to make the difference of any consequence. I recently tried the experiment of taking all the readily measurable objects within reach and getting their dimensions first with a rule divided to 32nds of inches and then with a millimeter scale. I could not have told by the result whether the makers had used one system or the other, although I have no reason to suppose that any object measured was really scaled to metric dimensions.

Thus there is no actual inconvenience in passing from one system to the other, for a carpenter would make for instance a box or a blacksmith a tire as readily to metric as to English dimensions as soon as he learned to read the metric rule, which might consume five minutes of his valuable life. Measurements to gauge requiring great precision demand the same care by either system and are made with equal facility. But the plain fact is that once metric measures are put in use we shall hear no more of dimensions like 5 13/32 in., for no one will specify such outlandish, vulgar fractions when simple units are in use. If I want a bookcase made with about 7½ in. spacing between the shelves, I shall call for 19 cm. and think no more about it. It does not make the slightest difference to me whether I buy a half-pound package of tobacco or one containing

250 grams, and the advent of the liter would merely mean a trifle fuller quart. Any one who has ever lived in a metric country falls into the local usage in a few days and thinks no more about it.

The strongest reason for taking up the metric system is the enormous convenience of working an inter-related decimal system of weights and measures in a country where the coinage and the system of notation are decimal. The meter is the base of a very useful system that fills all the requirements, is used all over the world for exact measurements, and commercially by a huge majority of civilized nations. Moreover, our own present weights and measures are already legally defined in metric units for the reason that there are no standards of any consequence save metric.

The measure now being urged upon Congress is merely to affect Governmental transactions by way of getting people to consider the metric question from a practical standpoint. There is every reason to suppose that it will slip quietly into use without causing any friction, and while a few ultra-conservatives will probably talk ostentatiously of rods and scruples for some years to come, they will pass off the stage like their great grandfathers who stood staunchly by pounds, shillings and pence, and that will be an end of the matter. The whole argument for the English system seems to be based on a misconception of what it really means to use the metric system, and the simplest possible way to convince the conservative of their mistake is to give them a chance to see its actual workings in the Government service.

CHICAGO, ILL. CHARLES L. STONE.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

REFERENCES.

Winter-Eichberg Motor.—MÜLLER.—An article illustrated by diagrams in which the author first compares the action of the single-phase induction motor with that of the Winter-Eichberg motor, and then gives the mathematical theory, illustrated by diagrams, of the latter motor. He deals at some length with the problem of commutation.—*Elek. Zeit.*, October 27.

Design and Construction of Small Motors and Dynamos.—POOLE.—The second in the series of article on the above subject. Preliminary formulæ and corrections, rules and instructions for laying out the armature are given. The article contains tables of armature current and watts, armature diameter constants, general data, current-carrying capacity of round armature wires and slot dimensions for standard sizes of round armature wires, double cotton insulation.—*Amer. Elec.*, November.

LIGHTS AND LIGHTING.

REFERENCE.

High-Efficiency Lamp.—See the abstract of a Swiss Electrical Society paper under "Miscellaneous."

POWER.

Motor-Driving of Machine Tools.—A long discussion on this subject before the Franklin Institute. It was opened by C. Day, who emphasized that until it is fully understood that the words "a motor-driven tool" need not necessarily imply high efficiency, the advantages made possible by the use of the best types of such apparatus will not be gained. He considered the motor drive from the standpoint of a money-earner. Everything depends upon the proper selection of motors and controllers, followed by intelligent installation and operation. G. S. Dunn emphasized the necessity of reliability of operation, with a minimum of interruption through controller or motor trouble; controllers for machine tool duty have recently undergone a marked evolution. He thinks that the individual drive will soon be adopted for even very small machines. F. B. Duncan expressed the belief that what is needed is a complete re-design of present machine tools with motor operation alone in view; the idea must be abandoned that standard motors can be bought and "hitched up" to a tool originally designed for a belt drive, with the result of obtaining a satisfactory outfit. It can only be done in a very few instances, and what is needed is an entire line of machine tools designed electrically and mechanically for the production of the greatest amount of work in the shortest possible time. H. B. Emerson, in speaking on electric speed control, seemed to prefer the three and four-wire system, combined with field control. There are a great many mechanical speed changers on the market, all of which are more or less imperfect in design. If such a device is perfected, it would revolutionize machine tool driving, as a constant-speed motor only will be required, and the induction motor would supplant the direct-current motor now in use. F. M. Kimball remarked that the higher the trade unions drive the price of labor and the larger the market becomes for any given item of product, the more advantageous will it become, from all standpoints, to adopt individual drive as against group drive. In general problems of machine equipment, speed variation by the motor of 1 to 3 on single voltage, and 1 to 6 on double voltage is all that is necessary. The remaining requirements can better be met mechanically. R. T. Lozier outlined a general method of arranging the motors and their speed range in a machine shop. J. Christie said that individual constant-speed motor drives have been in use for many years in the Pencoyd bridge shop; they have recently installed a multi-voltage system in their machine shop. The effect of having a wide range of speed under easy control is an encouragement to the workmen to experiment with cutting speeds, and they quickly learn the maximum speed which material and tool steel will allow. A great deal of the trouble incident to the use of a multi-voltage system arises with the controllers. Most of it is confined to the controllers on the smaller machines; the small nature of the work requiring far more frequent stopping and starting, with the consequent wear and tear, than on the larger machines. Field regulation has not proved entirely satisfactory in some cases, sparking and momentary variations in the motor speed being the consequence. "It is best that reduction in speed be obtained whenever possible by the use of the back gears, rather than by using a lower voltage, not only because a higher efficiency is insured, but also to avoid having too large a proportion of the shop power drawn from the low voltages, with consequent overloading." The increased cost of installing a multi-voltage system over that of a constant-speed system is said to be considerable. Elihu Thomson expressed the opinion that there is no hard-and-fast rule which can be laid down, everything depending on the conditions of use of the machine tools. In some cases the group drive will undoubtedly hold its own, and perhaps in other cases the belt, counter and line shaft will be retained. W. Cooper spoke of shunt field regulation in connection with the multiple-voltage system and as a result of its introduction he mentioned that where formerly the four-wire circuit for a multiple-voltage system with a ratio between the extreme voltages of about 6 to 1 had been used, the same results could be accomplished by using a range of voltages of about 2½ to 1 and a three-wire system. The total range of speed, using both variable-voltage and field regulation, is as the square of the range of voltages. The change of horse-power is directly proportional to change of voltage on armature, field being constant. The change of horse-power by change of field strength is inversely proportional to change in speed, the voltage on the armature remaining constant. The relative size of motor, as referred to the maximum speed, is directly proportional to its speed variation when using variable voltages. The relative size of motor, as referred to the maximum speed, is as the square of the speed variation when using field regulation.—*Jour. Franklin Inst.*, November.

Electrical Equipment of Type Foundry.—An illustrated description of the plant of the American Type Founders' Company, at Communipaw, N. J. The power house is situated some distance from the main works and steam and electricity are conveyed to the works by pipes and cables placed in an underground trench. The generating equipment consists of three direct-connected units generating current at 125 volts. The general electrical distribution is on the two-wire system. The distances from the power house to the various points of current consumption are not very great, so that even with the maximum distance, the e.m.f. generated is sufficiently economical.

In the electrical operation of the type-casting machines excessive speed variations are required, since the size of type made by the machines varies from a letter 1/32 in. to one 2½ in. wide, and the speed of the machines must be varied according to the size of the type being cast; the pumping of the metal, cutting, trimming and notching of the type requires a longer period with the larger type than with the smaller sizes. The machines are equipped with Stow multi-speed motors, and the motors are back-geared. A wide range of speed variations is obtained by rheostatic control in combination with the method used on the motor of changing the magnetic reluctance of the field. Electricity is used exclusively for power and lighting.—*Amer. Elec.,* November.

REFERENCES.

Charging Furnaces.—An illustrated description of electrically-operated machines for charging Siemens-Martin furnaces. The machine is capable of making eight different motions, by means of four enclosed 220-volt, direct-current series motors, each being able to run in both directions and giving 12 hp at 800 r.p.m. The machine is able to handle a charge of 1,000 kg. weight.—*Elek. Bahnen,* October, Heft. 20.

Feed Water Heating.—STROHM.—An illustrated article on feed water heaters, dealing with the necessity of feed water heating, a description of the various typical types of feed water heaters, their construction, operation and applicability.—*Amer. Elec.,* November.

TRACTION.

Railway Generating Station.—A description of the Lot's Road generating station of the Underground Electric Railways Company, of London. This station, which is the largest of its kind in Great Britain, is now rapidly nearing completion, the switch gear being practically finished. When the station is complete there will be 80 boilers, arranged in 10 batteries of 8 boilers each. Directly opposite each battery of boilers is situated a generator set. The turbines are of the Westinghouse-Parsons, four-stage, parallel-flow type. Each is coupled to a three-phase generator rated at 5,500 kw, and having an overload capacity of 50 per cent. for two hours at practically the same consumption of steam per kilowatt-hour. When running at 1,000 r.p.m. these machines generate 11,000 volts at a frequency of 33⅓. The generators are excited by four 125-kw, 125-volt, continuous-current dynamos, driven by reciprocating engines at a speed of 375 r.p.m. They are star-wound, and the neutral point is connected to earth through a resistance which limits the current going to earth to 1,000 amp. The negative excitation leads are connected directly from the exciters to the generator fields, by means of duplicate cables. The switchboard is of the remote-control type, and occupies three galleries running the entire length (454 ft.) of the engine room. The article is fully illustrated.—Lond. *Elec.,* October 21.

Changing the Gear Ratio on a Series Railway Motor Equipment.—A discussion of the effect of changing the gear ratio on railway motor equipments, giving a number of curves obtained during certain tests. The conclusions are as follows: The effect of changing the gear ratio on a car equipment is: Increased car speed and a correspondingly decreased tractive effort for increased gear ratio for a given value of current. Increased tractive effort for a given car speed with increased gear ratio. Increased maximum speed available and an increased current attending this maximum speed, which increases the motor heating for an increased gear ratio. While a high ratio operating on runs having a long grade shows economy of power in its favor, the erratic load of such heavy pulls for a short time on the supply station, and the tolling effect on drop, car lights and other cars running more than offset any saving of power that shows to its advantage. As a general proposition, the best gear ratio to use on a given equipment for a given schedule speed is the lowest gearing that with a fair margin will maintain the specified schedule.—*St. R'y Jour.,* October 29.

Oregon.—An illustrated article on the territory, construction, power transmission and rolling stock of the Oregon Water Power & Railway Company. This company operates in Northern Oregon an electric railway. Besides carrying the usual 550-volt railway current and feeders, the cedar pole line is also used to convey a 11,000-volt, three-phase transmission system from the temporary steam-driven power station at Boring to the sub-stations at Gresham and Eagle Creek. The high-tension wires pass over triple petticoat glass insulators set on eucalyptus pins. The city lines are operated by rented power. The present power plant of the company, which consists of a Corliss double engine connected to a 600-kw revolving field alternator, will be replaced by a large hydro-electric station on the completion of the Clackamas River plant. The initial installation will consist of three 2,500-kw, 2,200-volt, 33-cycle, three-phase generators, with provision for two more. A feature will be the transmitting of the entire product of the station at machine voltage across the river, which is about 348 ft. wide, to the step-up transformer house. The current for transmission to the railway sub-stations will be raised to 11,000 volts and the remainder, which will be sold for power purposes in Portland, at 33,000 volts.—*St. R'y Jour.,* October 22.

Brakes.—KRAMER.—The conclusion of his long serial on brakes for electric street railways and on means for increasing their efficiency. The author deals with the solenoid short-circuit brake, which he finds fulfills all requirements and is at the same time very effective. He describes a simplified arrangement of this brake and then deals with the short-circuit air brake in which the motors are short-circuited while simultaneously the short-circuit current influences a compressed air regulator for the brake cylinder. While such a brake is very expensive, it fulfills all other requirements.—*Elek. Bahnen,* October, Heft 20.

Gasoline-Electric Omnibus.—A description of a coach of the gasoline-electric type. The engine and generator are supported from the main frame under the hood in the extreme front of the car. The two motors which drive the car are mounted near the rear end and connected to the rear wheels by chains. The steering mechanism consists of the standard wheel construction connected to the front wheels through irreversible worms. The engine is of 4-cylinder, 4-cycle type, having a capacity of 40 hp at 700 r.p.m. It is direct-connected to a 6-pole, 6-kw generator wound for 85 volts. The speed of the 20-passenger bus on a good road and weighing 4.5 tons is estimated at 12 miles per hour, and its economy is between 15 ton-miles and 20 ton-miles per gallon of gasoline.—*St. R'y Jour.,* October 29.

REFERENCE.

Electric Freight Locomotive.—Detailed specifications of a 200-hp electric freight locomotive used by the Philadelphia & Reading Railroad. This locomotive has a full-load drawbar pull of 6,615 pounds and runs at about 10¼ miles an hour.—*St. R'y Jour.,* October 29.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Automatic Potential Regulator.—GRAY.—An illustrated description of a device by which potentials from about 5,000 volts on which were kept up by a Toepler-Holtz machine driven by an electric motor, were maintained more constant than was possible with an ordinary point overflow to earth. As shown in Fig. 1, a light disc, *A,* of

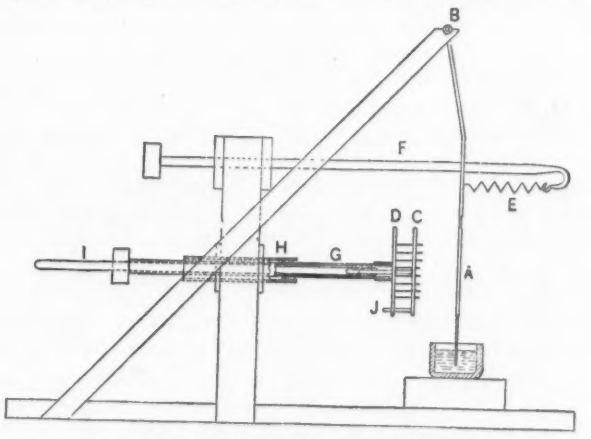


FIG. 1.—POTENTIAL REGULATOR.

polished metal is suspended by means of an insulating rod from a suitable support so that it can rotate with the least possible friction about a horizontal axis, *B.* Opposite *A* is mounted another disc, *C,* through small holes in which project a great number of sharp needles fastened into a disc, *D.* Extending downward from *A* is a rod carrying at its lower end a light metallic plate, which serves at the same time to damp the motion of *A* and to make electrical connection between it and some slightly diluted glycerin contained in a glass trough, resting on a block of paraffin. The glycerin has dissolved in it a little calcium chlorid or other salt to render it conducting,

and is prevented from creeping over the edge of the trough by slightly greasing the upper part of the glass. A wire dipping into the glycerin connects *A* with the positive terminal of the electrical machine, while another connects *C* and *D* with the negative. The needle points opposite *A* form a number of ordinary point overflows which are all in operation at the same time, so that the potential difference between *A* and the needles is maintained at a fairly definite value, depending on the distance between them, as the source of electricity furnishes a sufficient supply. Any increase in the potential causes the disc, *A*, to move toward the points, thus hastening the overflow, while a decrease causes the spring, *E*, to draw *A* away and lessen the action of the points.—*Phys. Rev.*, November.

REFERENCE.

Charging for Electrical Energy.—See the abstract of a Swiss Electrical Society paper under "Miscellaneous."

WIRES, WIRING AND CONDUITS.

REFERENCES.

Submarine Cable Construction.—MEDINA.—A paper read before the Technical Society of the Pacific Coast, giving some particulars of design and construction, laying and maintenance of submarine cables, with special reference to the Commercial Pacific Cable Company's cable between San Francisco and Manila, the laying of which was completed on July 4, 1903.—*Jour. Ass. Eng. Soc.*, September.

Determination of Current Strength in a Star Three-Phase Network.—ROGOWSKI.—A modification and simplification of the method of Kennelly described in ELECTRICAL WORLD AND ENGINEER, August 19, 1899, page 268.—*Phys. Zeit.*, October 15.

Some Hints on Conduit Work.—MCMACKIN.—An illustrated practical article on the installation of conduit. A variety of hangers for suspending conduit from I-beams are illustrated and described.—*Amer. Elec.*, November.

ELECTRO-PHYSICS AND MAGNETISM.

Coherer.—HARDEN.—The author has formally expressed the opinion that the action of the ordinary metallic coherer is due to small sparks which are caused by the high potential of the vertical wire, forming a bridge over the gap and producing a metallic connection through which the current then passes. If this is true the best conditions for a coherer with a single contact point are obtained, if the contact point is not in air of atmospheric pressure, but in an evacuated atmosphere of maximum conductivity. This corresponds to 0.3 mm. mercury. The arrangement of the experiment is shown in Fig. 2. The contact point, *d*, is contained in a closed glass tube, *D*, and consists of two platinum wires, the air-gap between their ends being about 0.2 mm. long. The tube, *D*, is connected with a larger vessel, *B*, and evacuation is performed while the conductivity is measured by means of an induction coil connected to the electrodes, *c c*. Evacuation is stopped when the conductivity is a maximum. Then the connections of the platinum wire, *p*, are made to earth, *E*, a battery, *d*, a galvanometer, *g*, and the vertical wire, *A*. Current passes through the galvanometer as soon as an elctromagnetic wave acts on the vertical wire, *A*, and continues to flow as long as the wave acts on the vertical wire. After that decoherence is automatic.—*Phys. Zeit.*, October 15.

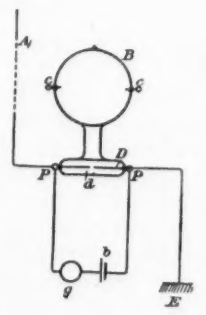


FIG. 2.—COHERER.

N-Rays.—SALVIONI.—An account of a series of laborious experiments made for the purpose of testing Blondlot's N-ray observations. As a general result, he is of opinion that there is some objective reality of the phenomena mixed up with a number of subjective elements. He is driven to this conclusion by the extreme clearness with which he observed a few of the appearances, such as the effect upon a line of calcium sulphide, and the maxima and minima from which Blondlot deduced the wave length of the rays. On the other hand, he has failed in obtaining positive results by any of Blondlot's "objective methods," and has found that physiological and psychological elements have a considerable influence. Both he and his assistants worked themselves into a state in which a bewildering variety of luminosities appeared to them, but found that a few months' rest left them in a state less fit than ever to obtain positive results. The author points out that the phenomena, especially on the medical side, show a suspicious resemblance to "animal magnetism," though such resemblance should, of course, not prejudice truly impartial investigators.—*Nuovo Cimento*, August; abstracted in Lond. *Elec.*, October 21.

Dimensions of Physical Quantities.—JOHNSON.—A note on the ambiguity existing in the different systems of dimensions for physical quantities. There are already doubts as to the dimensions of force in mechanics. Kirchhoff denied the necessity of the conception of force in mechanics and Mach has recently taken the same position. The present author does not assume any definite dimensions for force, and shows that if they are left undetermined and the dimensions of the electromagnetic system are calculated, it is found that resistance, capacity and self-induction are entirely independent of the dimensions of force. If the conception of force contains something indefinite, the same must be said concerning the definition of mechanical potential. This would lead to the refutation of the electrostatic system.—*Phys. Zeit.*, October 15.

Radium.—LIEBENOW.—An article showing that for maintaining the temperature of the interior of the earth, the radioactive substances, the presence of which in the earth is at least very probable, are quantitatively sufficient. If they are in fact the cause of the elevated temperature in the interior of the earth and if, as seems to be the case, they are distributed uniformly near the surface of the earth only, it must be concluded that the temperature increases with increasing depth only near the surface. Below the region of radioactive masses the temperature of the interior of the earth would have a constant maximum value, which is perhaps not very high.—*Phys. Zeit.*, October 15.

REFERENCE.

Alternating-Current Diagrams.—An illustrated didactic article on alternating-current diagrams. Sine curves and vectors are considered.—*Amer. Elec.*, November.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrometallurgy of Iron and Steel.—The complete report of the commission appointed by the Canadian Government to investigate the different electrothermic processes for the smelting of iron ores and the making of steel in operation in Europe. The chairman of the commission was Dr. E. Haanel. The report contains first detailed descriptions by Haanel of the Kjellin, Héroult, Stassano and Keller furnaces, with excellent photographs and detailed drawings of the furnaces; also shorter notes on the Harmet and Gin processes. Then follows the report of the electrician, C. E. Brown, giving details on the method of making the electrical measurements. He gives the following cost of electrical energy consumed in the various processes on the basis of the cost of $10 per hp-year. For the reduction of pig iron from ores the cost of electrical energy per metric ton of pig was $5.25 for the Héroult process and $5.30 and $2.50 for two runs of the Keller process. For making steel the cost of electrical energy per metric ton of ingot was $1.30 and $1.60 for two runs of the Kjellin process, $1.70, $1.70, $1.11 for three runs of the Héroult process, and $1.25 for the Keller process. This is followed by the report of the metallurgist, F. W. Harbord, who reaches the following conclusions: Steel, equal in all respects to the best Sheffield crucible steel, can be produced, either by the Kjellin or Héroult or Keller processes, at a cost considerably less than the cost of producing a high-class crucible steel. At present, structural steel, to compete with Siemens or Bessemer steel, cannot be economically produced in the electrical furnaces, and such furnaces can be used commercially for the production of only very high-class steel for special purposes. Speaking generally, the reactions in the electric smelting furnace as regards the reduction and combination of iron with silicon, sulphur, phosphorus and manganese are similar to those taking place in the blast furnace. By altering the burden and regulating the temperature by varying the electric current, any grade of iron, gray or white, can be obtained and the change from one grade to another is effected more rapidly than in the blast furnace. Gray pig iron, suitable in all respects for acid steel manufacture, either by Bessemer or Siemens processes, can be produced in the electric furnace. Gray pig iron, suitable for foundry purposes, can be readily produced. Pig iron low in silicon and sulphur, suitable either for the basic Bessemer or the basic Siemens process, can be produced, provided that the ore mixture contains oxide of manganese, and that a basic slag is maintained by suitable additions of lime. It has not been experimentally demonstrated, but from general

considerations there is every reason to believe that pig iron low in silicon and sulphur can be produced even in the absence of manganese oxide in the iron mixture, provided a fluid and basic slag be maintained. Pig iron can be produced on a commercial scale, at a price to compete with the blast furnace, only when electric energy is very cheap and fuel very dear. On the basis taken in the report, with electric energy at $10 per electrical hp-year, and coke at $7 per ton, the cost of production is approximately the same as the cost of producing pig iron in a modern blast furnace. Under ordinary conditions, where the blast furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water power is available, and blast furnace coke is not readily obtainable, electric smelting may be commercially successful. With respect to these conclusions of Harbord, the following remarks are made by Haanel. He agrees with everything that is said concerning the electric production of steel. In reference to the production of pig iron he points out that the results obtained at Livet were obtained in furnaces not specially designed for the production of pig iron from ores. With improved furnaces, better results can be obtained. "The modern blast furnace and the different methods for the making of steel as at present employed, are the result of a hundred years of experience, and have reached their present perfection through many modifications, which, in many instances, were accepted and introduced into practice only after much hesitation and opposition. The process of the electric reduction of iron ore must yet be regarded as in the experimental stage; in fact, no plant exists at the present time where iron ore is commercially reduced to pig by the electric process. The more remarkable, therefore, it appears, and the more gratifying it is regarding the future of electric smelting, that experiments made offhand, so to say, in furnaces not at all designed to be used for the production of pig should give a figure of cost which would enable the experimental plant employed to compete with a blast furnace in regions where electric energy can be had for $10 per electrical hp-year, and where coke is quoted at $7 per ton." Haanel states that he is "credibly informed that the water power at Chats Falls can be developed at a cost to produce an electric hp-year at the rate of $4.50. There are probably many water powers favorably situated as regards good bodies of ore in the Provinces of Ontario and Quebec, which can be developed as cheaply." The report is concluded by an account of the Ruthenburg process and by translations of papers by Harmet, Gin and Stassano on the electrometallurgy of iron and steel and a paper by Vattier on the Keller process of treating copper ores in the electric furnace.—Report published by the Department of the Interior of the Canadian Government.

Production of Ozone.—GRAY.—An illustrated paper on the production of ozone by silent discharges in the Siemens ozonizer and on an improved construction of this apparatus. The three main points are stated to be, first, good surface insulation of the generator, both internal and external; second, dry oxygen; third, charging and discharging as suddenly as possible. For this reason the resistance and self-induction of the circuit should be reduced to a minimum, and it is also possible that operation by connection with a Léyden battery might yield better results than the ordinary method of employing an induction coil or an alternating-current dynamo, as these machines cannot give such a rapid change in the potential difference between the electrodes. Merely placing the generator in parallel with the spark-gap of an electrical machine, as was done by Shenstone and Priest, is inefficient, because the charging takes place so slowly that no illumination, and consequently no ozone, is produced.—*Phys. Rev.*, November.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Sensitive Moving Coil Galvanometers.—WHITE.—An article on the principles underlying the construction of sensitive moving coil galvanometers and on various experimental devices for increasing their sensibility. The chief points, brought out by the author, are as follows: In all galvanometers a counter e.m.f. is produced by the motion of the coil or magnet, which seems to cause a damping effect. When there is no appreciable waste of energy and when the counter e.m.f. is sufficient to make the motion just barely aperiodic, the galvanometer has the maximum possible effectiveness, as far as utilizing the energy of the current is concerned, and this effectiveness is the same for all such galvanometers. The power of the magnet in moving coil galvanometers renders easy the securing of the above condition, in ordinary cases. The sensibility for given resistance and period then depends solely on the deflection produced by a given quantity of energy. Moreover, for such moving coil galvanometers as are generally used, the limit of delicacy of construction is set by the size of the suspending wires. It follows that the normal sensibility depends solely on the directing force of the coil and is proportional to the square root of that. When resistance or period is changed, the sensibility is proportional to $\sqrt{R\,T}$, when R is the resistance of the whole circuit and T the period. To employ instead of this formula the one derived from the Kelvin galvanometer gives misleading results. A further result of the magnet power of the moving coil galvanometer is the ability to replace part of the wire of the coil by other masses without loss of sensibility. This type is thus by far the best when pointers, etc., are to be moved, as in lecture table apparatus. For the same reason the width of the coil has, in general, no effect on the sensibility. A change in the width of the coil has, electrically, the same effect as a change in the size of wire in the coil. Coil resistance and magnet strength may, to a large extent, be substituted one for the other. The dynamic constant is proportional to the product of the field strength by the square roots of the coil resistance and of the moment of inertia. Trouble arising from magnetic impurities in the coil is reduced to one-sixtieth by using a radial instead of a uniform field. It is easy to make a simple and "robust" moving coil galvanometer that shall have an effective sensibility of 560 megohms for 100 ohms resistance and a period of 1.3 seconds. The internal resistance cannot then be brought much under 20 ohms. A separate mirror promises a very considerable increase in this sensibility. Attempts to increase sensibility by decreasing the control below the limit naturally set by the wire have not been successful. In securing high stability a device which can be supported by a basement floor is preferable to any arrangement, in itself equally good, which hangs from a wall or ceiling. A tank and float may thus be of greater advantage than a Julius suspension. It is very much better, when a float is used, to suspend the apparatus from its center of gravity. This is readily accomplished by making the float and tank annular. A jointless table permits taking advantage of a stable floor and excels in simplicity and portability.—*Phys. Rev.*, November.

Alternating-Current Compensated Voltmeters.—YOUNG.—An illustrated description of the alternating-current compensated voltmeter, prefaced by considerations which led to its adoption and use. The author describes a device which enables the voltmeter to indicate accurately the pressure at all times regardless of the current or character of the load. Means are provided for adjusting for circuits having a variable ohmic and inductive drop. The device consists of three parts: A current transformer, a resistance and a reactance, both of the latter being adjustable. These elements are all contained in a suitable frame arranged for mounting on a switchboard.—*Amer. Elec.*, November.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wireless Telegraphy.—ZENNECK.—A discussion of recent theoretical work in wireless telegraphy with a view to the practical application of its results. The difficulty of obtaining an agreement between the theoretical and actual frequencies of a transmitter lies in the unavoidable presence of wire ropes near the antenna, a difficulty which is increased ten-fold on board men-of-war. But though it may be impracticable to calculate the frequency, the resonance method devised by Bjerknes enables one to measure it with ease and rapidity. As regards the merits of multiple antennæ, the author remarks that a multiple antenna has the same effect upon the wave length as a single antenna of increased thickness, but without as much increase of weight. For equal lengths, the capacity of a multiple antenna is greater than that of a single antenna. Besides, the ratio of energy radiated to energy supplied is greater, so that multiple antennæ have a greater efficiency. The primary circuit of the Tesla transformer should have a high capacity and low inductance. It is best to let the primary circuit consist of a single turn of wire or several turns in parallel. The author differs from Drude as to the degree of coupling giving a maximum amplitude. Drude puts it at 0.6, but the author has obtained a maximum at 0.18, being a much looser connection. As regards the primary spark potential, the author shows that the maximum amplitude in the secondary system rapidly increases with the primary e.m.f. up to a sparking distance of about 4 cm. In cases where the damping factor is to be determined, the method of Bjerknes has been found to work well. It is advisable to vary, not the inductance, but the capacity of the reson-

ating circuit, and to measure the current by means of a bolometer affected by induction. The method yields the damping of the primary and secondary systems and the frequency of one system, when the frequency of the other is known, with sufficient accuracy.—*Phys. Zeit.*, October 1; abstracted in Lond. *Elec.*, October 21.

Registering Atmospheric Discharges.—FENYI AND SCHREIBER.—A description of an apparatus for automatically registering atmospheric electric discharges and thunderstorms within a district of about 100 km. radius. The coherer and a coil of wire of 0.2 mm. diameter, the resistance of which is about 100 ohms, are inserted in the circuit of a primary cell. In the center of the coil a magnetic needle is provided which is deviated as soon as the coherer becomes a conductor and closes the circuit containing the registering device. The circuit also contains an electric bell which produces decoherence, so that the magnetic needle returns to its original position. The coherer consists simply of two sewing needles placed crosswise upon each other. They behave like an insulator even if they are pressed together with a pressure of 6 kg. But the smallest spark makes the coherer conducting.—*Elek. Neu. Anz.*, October 15.

MISCELLANEOUS.

Swiss Electrical Society.—An account of the recent annual meeting of the Swiss Electrical Society and the Union of Swiss Electricity Works. Filliol gave an account of tests of fuses for current strengths up to 40 amp. Veterlaus reported on proposed modifications of safety rules, Wyssling on standardization of electric machines and on the work done by the committee for studying electric operation of railways. The latter committee has been organized and the programme worked out. Wagner reported on incandescent lamps. Since the incandescent lamp manufacturers have formed a syndicate, the quality of the lamps has grown worse. He recommends joining the International Association of Electricity Works, which endeavors to produce uniformity in the supply and in the tests of lamps in all countries belonging to the association. Uttinger reported on high-efficiency lamps. Replies upon an inquiry have been received from 70 plants, stating that the Nernst lamp (that is in its European form) is suitable only for direct current and especially for voltages above 200. In alternating-current plants the Nernst lamp has proven satisfactory only where the voltage variations were small. The quality of the filaments is said to have been improved and the so-called "intensive lamp" of 1 amp. has given satisfaction. Concerning the osmium lamp, which has been experimented with in alternating works only, complaints were made on the breaking of the filament, especially during the transport of the lamp. The German osmium lamp is said to be superior to the Austrian one. The results obtained with this lamp are not yet decisive. Experiments in which additions were made to the carbon in the filaments of incandescent lamps for the sake of a higher efficiency, have caused a decrease of the mechanical strength of the filament and therefore of the life of the lamps. The mercury vapor lamp of Bastian for public lighting gives 2½ candles per watt (32 watts for 80 candles at 60 to 80 volts). The Cooper Hewitt mercury vapor lamp is said to be too expensive. By combining the mercury vapor lamp with an ordinary carbon filament lamp, Bastian endeavors to produce a better color effect for interior lighting. Wyssling reported on methods of charging for electrical energy. For lighting, a flat rate is used in most cases. The reason is that the conditions were simple at the time of erection of the majority of the plants, and a flat rate represented the simplest solution for small works on account of the high prices of meters. For the utilization of water power without accumulation of energy, the number of hours of utilization of energy was of small importance. Later on the flat rate was modified into a sort of multiple-rate, according to the estimated number of hours during which energy is used. Where the energy is charged for on the basis of the readings of electricity meters, the fundamental rate has gradually decreased and has in some cases disappeared altogether, although the author believes that a combination of a fundamental rate with a rate based on the energy consumption is the theoretically correct method. Systems allowing discount according to the capacity of connections or the time of consumption or the total consumption are in general use. From power purposes rates based on meter readings, flat rates and rates representing a combination of the two are used. The flat rates for 24-hour power supply are especially low.—*Elek. Bahnen*, October, No. 20.

Electric Treatment for Rheumatism.—A note on a process devised by Stanger and Baker. A bath of impregnated wood is filled with a fluid consisting of a solution of extracts of barks and herbs and of a certain percentage of tannic acid. Ten carbon electrodes in the form of large rectangular plates hang down into the bath at either side. The voltage across the terminal strips may be regulated by a rheostat and is usually about 30 volts. The current, about 2 or 3 amp., flows from one set of electrodes to the other set and may be localized or varied in strength by suitable fixture of the electrodes.—Lond. *Elec.*, October 21.

REFERENCE.

Biographical.—The first of a series of biographical sketches of prominent central station men. The subject of the first sketch is John W. Lieb, president of the American Institute of Electrical Engineers, and assistant general manager of the New York Edison Company.—*Amer. Elec.*, November.

High Speed Chain-Drive in Motor Plants.

BY GEORGE HILL.

Some two years ago my attention was called to high-speed chain driving as a means of transmitting power from electric motors to line shafting, countershafts and individual machines and tools, and I immediately commenced an investigation as to the merits of this form of power transmission. For power transmission its completeness and convenience of application as well as the positive speed ratio obtained make it very desirable, the question of its use depending on the price as well as the durability and efficiency. At the particular time in question I was rebuilding the vulcanized rubber company's works at Morrisville, Pa., with the idea of using motor drives in practically every case, with the exception of the main line shaft. The nature of the work, especially in the buffing departments, required very high-speed motors, and it was somewhat of a question whether a chain joint could be found that would stand these speeds without rapid wear taking place, but after obtaining samples from the different manufacturers, the "Silent Chain," manufactured by the Morse Chain Company, of Trumansburg, N. Y., was selected as the one best adapted for the particular service in view.

The main shaft in the old mill was formerly driven by spur gearing direct from the engine, as a positive drive was desirable, but this method of connecting to the line shaft was objectionable in the new mill on account of the noise made by the gears, because we wanted clear alleys on each side of the rubber rolls and finally wished to group all of our engines in one engine room. The new design called for two independent 200-hp Corliss engines arranged to drive to a jack shaft, and a second drive from the jack shaft to the main line, one engine to be a relay in case of breakdown or need of repairs. To drive through belting, while possible, was hardly practicable. It was estimated that at least 24-ft. centers would be required, while according to the chain design these centers could be reduced to as short a distance as permitted by the engine construction. The reduced center distances incident to the use of the chain permitted of reducing the floor space in the engine room some 750 sq. ft., which amounted to a saving in the cost of this building of $1,000, with the difference in the cost of the chain and belt drive of about $500 in favor of the chain. The high efficiency claimed by the makers, if sustained, would show a continuous saving in power consumption, and this, in connection with the less space required, decided me to use the "Silent Chain."

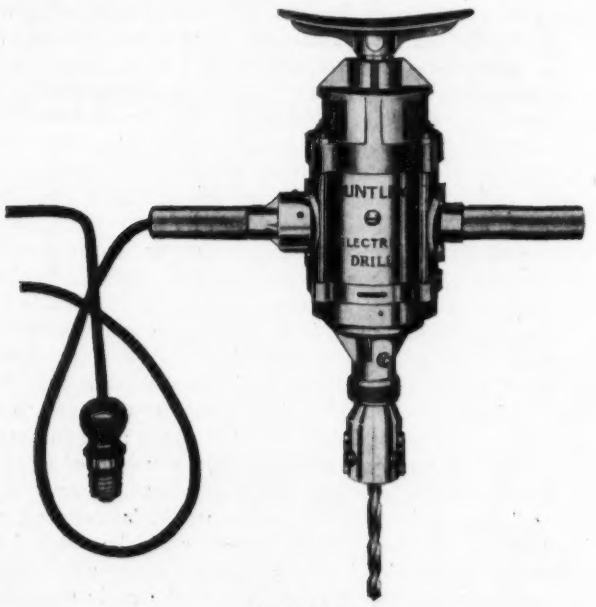
The drive is from the engine direct to the jack shaft on 7-ft. centers, with the necessary sprocket wheels on a similar engine some 10 ft. away, so that these chains could be uncoupled and placed on the other sprocket wheels in case of a breakdown of the regular driving engine. The second transmission is from this jack shaft to the line shaft on 14-ft. centers, the total distance of the engine from the main shaft being about 20 ft. The nature of the work in a rubber mill is one that constantly brings sudden shocks on the transmission gearing, but notwithstanding this, no link or tooth wear, or perceptible lengthening has taken place in these main driving chains, since the starting up of the mill in October, 1903, and a joint pin removed shows practically no wear on the rocking surfaces. The speeds of these chains are about 1,150 ft. per minute, and they have required but little attention in the way of lubrication, and make practically no noise when running.

There are forty motor drives, operating principally individual tools in connection with the work in the factory, though a number of them are used for blower and pump drives. The cost of the individual

drives from the motor was much more than for leather belting, but the "Silent Chain" has a most decided advantage on account of the positive speed ratio obtained, less space required, higher efficiency and greater durability, making it the more desirable transmission to use. Loss of time repairing belts is a considerable item each year that costs in the delivery of an order frequently far more than the chains cost. The efficiency claimed by the makers was practically 99 per cent., and on the large speed ratios used, one could hardly expect to obtain an efficiency of over 94 per cent. by the use of belting. This difference in efficiency between the two methods of transmission would, if the chain were as durable as claimed, save enough in the power cost alone to renew the chain when worn out.

An Air-Cooled Electric Drill.

The small portable air drill has found such favor in machine and repair shops that now its use could hardly be dispensed with. Its great drawback, however, has been that it could be used only in those shops where compressed air was to be had. The small repair shops and many other places where drills are required are not usually supplied with compressed air and for service in such places the Duntley air-cooled electric drill has been designed. This drill, one type of which is shown in the illustration, has been recently put on the market by the Chicago Pneumatic Tool Company. It consists essentially of a well-enclosed and protected electric motor connected through a planetary gear to a shaft carrying a standard drill



ELECTRIC DRILL.

chuck. Current is obtained from any incandescent lighting circuit by removing a lamp and screwing in its place the plug shown in the illustration. This plug is provided with a 5-amp. cartridge fuse that protects the motor in case the drill for any reason becomes stalled.

The drill is started by giving the handle on the left a partial turn. Another partial turn throws the current off. Heretofore attempts to produce a tool of this kind have met with difficulty because of the heating of the motor. In such a tool the motor must be well enclosed to protect it from rough usage, and when so enclosed the heat generated is dissipated more slowly. A motor of sufficient power to operate the tool and still not overheat necessitated so much weight as to make the tool unwieldly.

In this drill a fan is arranged to drive a continuous stream of air through the motor casing whenever the drill is in operation. This not only prevents heating but enables a much smaller motor to be used. The air enters the casing through small perforations in a piece of sheet metal, and there is, therefore, no danger of injurious substances getting into the working parts of the motor. Heating tests have been run on the motor by operating it continuously for a period of two hours. At the end of the run, it is said, the motor was comparatively cool.

The drill shown in the illustration is adapted for drilling holes in iron up to ½ in. in diameter. It weighs but 12 pounds, this small weight being partly due to the aluminum castings used in its construction. The illustration shows the drill provided with a breast plate, but is also furnished with a feed screw, when desired. The speed of the drill is 850 r.p.m. One would suppose that a motor as small as this would be easily stalled, but the weight of two men of ordinary size upon the breast plate, it is said, is not sufficient to do this.

Under load the current required depends upon the size of the drill, the material being drilled and the pressure upon the tool. At normal load it consumes somewhat less than 5 amp. on a 110-volt circuit, a fuse of this size being supplied with it. The maximum current, however, is about 6½ amp. on a 110-volt circuit.

The machine is especially adapted to facilitate repair work in machine shops, electric and steam railway shops, automobile factories, on steamboats and ocean liners and in fact in any place where 110 or 220-volt electric current is obtainable. It is as well adapted for drilling in marble, slate and wood as for work in iron. The drill should in a short time become as indispensable to the repairman as is the pneumatic drill to the machinist.

Electric Drive for Paper Mill Work.

The Consolidated Water Power & Paper Company, of Grand Rapids, Wis., is operating an electrically-driven plant, which has given such satisfactory results from its machinery that visiting paper makers find the plant of unusual interest. The Consolidated Company employs electricity in its work to a greater extent than has ever been undertaken before. There are, of course, a number of operations performed by machines direct-connected to turbine shafts and belted to line shafting, but the operations are largely performed by machinery driven by electrical apparatus built by the Northern Electrical Manufacturing Company, of Madison, Wis.

The river at Grand Rapids necessitates a dam 1,707 ft. wide. An average head of 40 ft. is secured with about 10,000 hp available. There are installed eight 48-in. Samson turbines, two of which are used to drive the dynamo units, five to drive the grinding machinery and one to operate a line shaft driving beaters and Jordan machines.

FIG. I.—VARIABLE SPEED MOTOR.

The two Samson turbines in the dynamo room develop 1,000 hp each and are equipped with Lombard governors. Each turbine operates two generators, one being an alternator and one a 300-kw Northern direct-current generator. The alternating-current machines provide current for lighting service and for long-distance transmission. All of the current supplied by the direct-current generators is employed in the plant, and the dynamos carry a practically constant overload. There are two 40-kw direct-current exciters, each driven by individual turbines, as well as a motor-generator exciter set. The switchboard consists of 21 panels of blue Vermont marble, of which 9 are direct current, with one blank for extensions of the direct-current service, and 11 panels are for alternating-current work. Mr. V. D. Simons, electrician of the company, designed the board and is also responsible for the excellent transmission system throughout the plant, as well as the application of motor drive.

A storage pond is provided for pulp wood, which is floated down to the conveyor as required. The log conveyor is driven by a back-geared motor and lifted into the wood room. The pulp wood is taken to a 48-in. saw, direct-coupled to a spherical motor. A conveyor takes the pulp wood to a line of six barking machines located in the wood room. There are five 48-in. machines and one 60-in. machine, each direct-coupled to a motor. The output of the wood room as electrically equipped, is 60 cords per day of 10 hours.

From the wood room a conveyor driven by a back-geared motor

FIG. 2.—PLANT OF CONSOLIDATED WATER POWER & PAPER COMPANY.

FIG. 3.—WET ROOM.

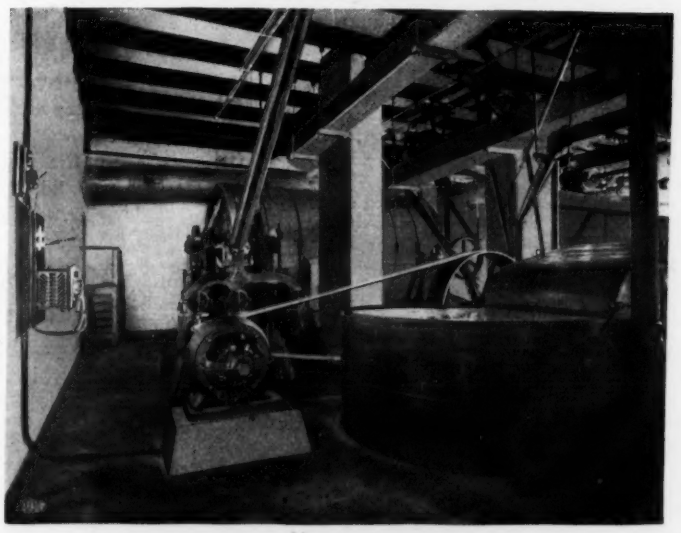


FIG. 4.—BEATER ENGINE.

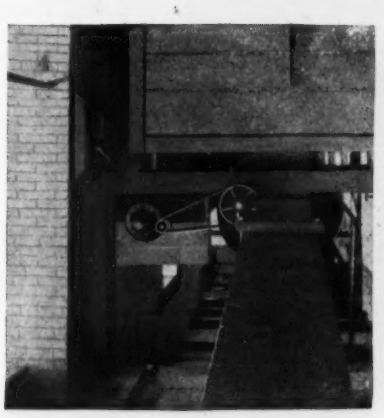


FIG. 5.—FILTRATION SYSTEM.

FIG. 6.—ANOTHER VIEW OF WET ROOM.

FIG. 7.—48-INCH SAW.

FIG. 8.—LOG CONVEYOR.

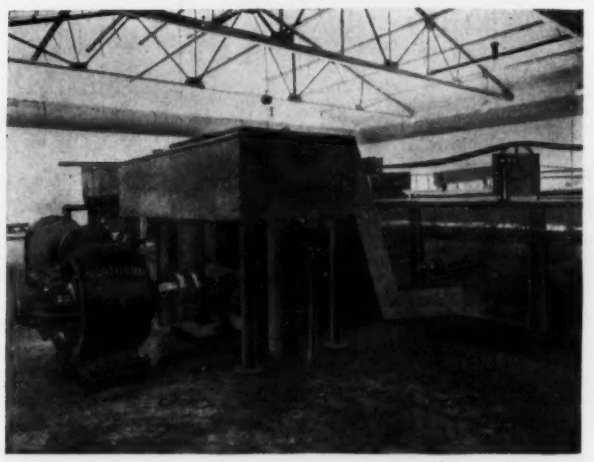


FIG. 9.—CENTRIFUGAL PUMP.

FIG. 10.—WOOD ROOM.

carries the pulp wood across the forebay on a bridge to the grinding room. After the operations here the pulp passes to the stuff chests preliminary to being put through the paper machines or carried to the wet room, where the refined pulp is worked up into heavy sheets and stored in this shape for future use. The wet room contains four 84-in. wet machines, each driven by a back-geared motor. If the pulp as ultimately refined is intended for immediate delivery to the paper machines, it goes through a series of stuff chests on the first floor and is subsequently lifted by motor-driven pumps to the machine room and delivered to one of the two paper machines used.

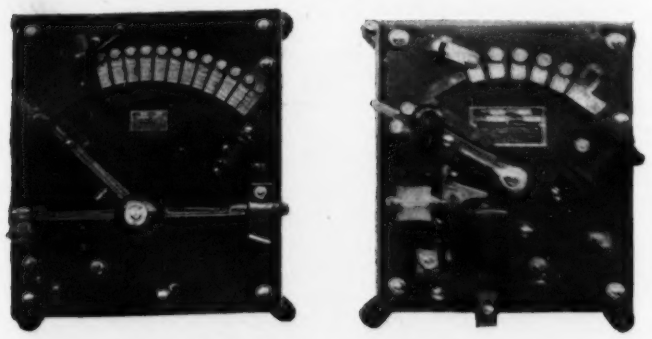
Chief interest in the motor drive of the plant of the Consolidated Water Power & Paper Company centers in the variable-speed motors installed for operating paper machines. Each paper machine is driven by an individual variable-speed motor located midway on a line shaft on the first floor. The motor affords variations of 300 to 500 r.p.m., equivalent to a speed of from 50 ft. to 500 ft. per minute in the paper machines. The lowest speed is employed for the movement of the paper machines for repairs or other work. The high speed used in actual production is from 450 to 480 ft. per minute. The paper machines are rated at 30 tons of print each per day, but the average total output is 65 tons and the increase is due in no small measure to the electric transmission machinery used for driving the paper machines. The machine room is thoroughly ventilated by means of two 72-in. fans, each driven by motors.

The finishing machinery consists of several splitters and a Holyoke cutter, all belted to a motor. Additional to the motor drive for the paper machinery, pumps, wet machines, conveyors, saw, barker, etc., there are several freight elevators driven by belted motors.

The visitor to the plant of the Consolidated Company is impressed by the freedom from the maze of belting usually associated with paper machinery, as well as the utter absence of noise caused by belt and line shaft drive. The cleanliness of the plant is especially noticeable, as well as freedom from suction drafts, belting, dust carried by belting, etc.

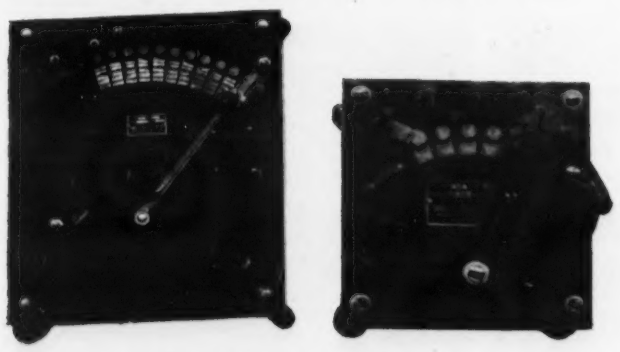
Motor Starters.

The Ward Leonard Electric Company, of Bronxville, N. Y., in its endeavors to design "fool-proof" motor starters, has developed



FIGS. 1 AND 2.—MOTOR STARTER.

the new types shown in the accompanying cuts. To prevent arcing at the initial contact of the starter, by an unskilled operator, there



FIGS. 3 AND 4.—MOTOR STARTER.

is supplied an independent, spring-actuated, renewable circuit-closing switch, which always opens the circuit with a quick snap break and with a magnetic blow-out. The stationary contacts which carry the armature current are in the form of brass segments, having a surface at the rate of one square inch per one hundred amperes.

The movable contact segment on the rheostat lever is in the form of copper skates or shoes, which can be readily inspected, removed and renewed. The contact skates have a universal movement, and will readily ride over any projections standing 1/16 in. above the surface of the segment. There is one independent, self-aligning, removable copper contact shoe for each forty amperes of the full rated current.

All parts shown upon the face of the starter are removable from the face of the starter without interfering with the rear connections. The no-voltage release magnet is connected directly across the line and the overload release is a circuit-breaker in series with the armature. This overload circuit-breaker prevents the motor from being started too rapidly and protects the motor against overloads both during the period of starting and at all other times.

Battery Motors.

The two accompanying illustrations represent a power motor and a fan motor recently brought out by Messrs. Kendrick & Davis,

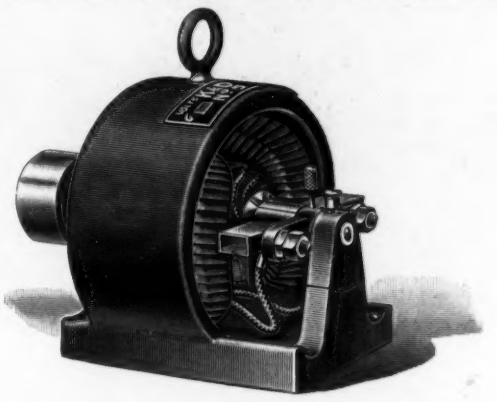


FIG. 1.—POWER MOTOR.

Lebanon, N. H. Both machines are intended to be operated by battery current, and in their design and construction they embody the best practice common to larger machines.

The field of the power motor is cast solid with the frame, the armature is of the drum type, and has six sections, and the brush holder is of an improved design, with adjustable yoke. The speed, on average load, is 1,800 r.p.m., the motor taking 2 amp. at 6 volts.

The special battery motor fan, in design and appearance, is similar to the regular 110-volt fan in common use. While it is practically an enclosed motor, the brushes and commutator are exposed for inspection. The bearings are of bronze and the provision for oiling is such that practically no attention is necessary in this re-

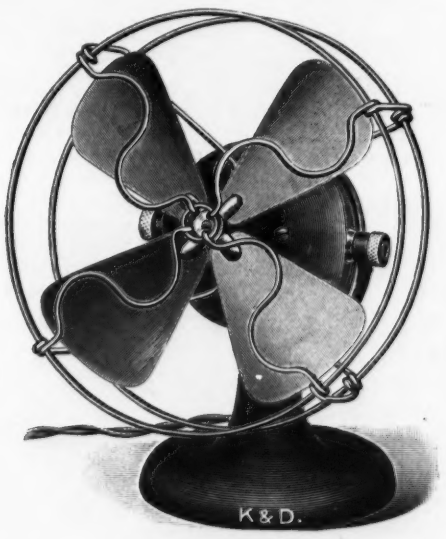


FIG. 2.—FAN MOTOR.

spect. The motor is supported on trunnions, which permit of tilting the fan at any desired angle. The operation of the machine is controlled by a switch in the base. The fan is 6 in. in diameter and the speed is 2,400 r.p.m., the motor taking ½ amp. at 7 volts.

"Erieco" Automatic Engine.

The Erie Manufacturing & Supply Company, Erie, Pa., has placed on the market a self-oiling automatic engine embodying the very latest thought in steam engine design. Fig. 1 gives a sectional view of the engine and Fig. 2 shows the shaft governor.

The engine frame is of the bored guide type, and at one setting of the frame it is bored out, the bearings for the pillow blocks spotted and the end of the frame faced ready to receive the cylinder. In machining the cylinder it is first planed and then the steam chest is clamped to the table of a boring mill, which bores and faces the cylinder at one operation, thus obviating the use of jigs, which are

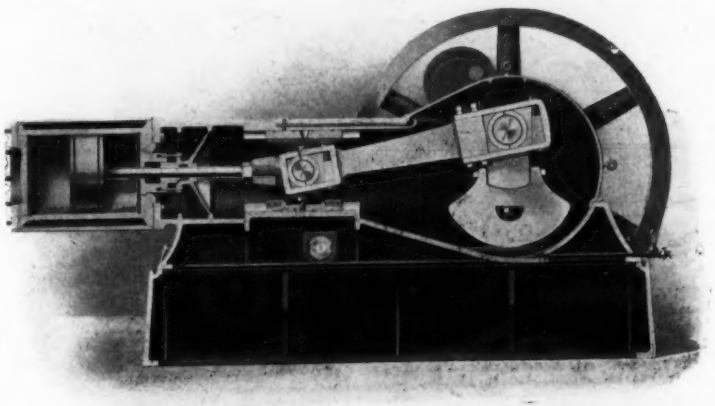


FIG. 1.—SECTIONAL VIEW OF ENGINE.

apt to distort the shape of the cylinder and make perfect alignment very difficult. The ports are designed to allow a very quick entrance of the steam, thus eliminating all back pressure.

After experimenting with a great many types of valves that have been used in high-speed engines, a double-ported flat slide valve was adopted, with an extra heavy pressure plate, which makes it perfectly balanced. The pressure plate and both sides of the valve, as well as the valve seat in the cylinder, are scraped to an accurate surface.

The governor is of the Riblet automatic type and consists of but

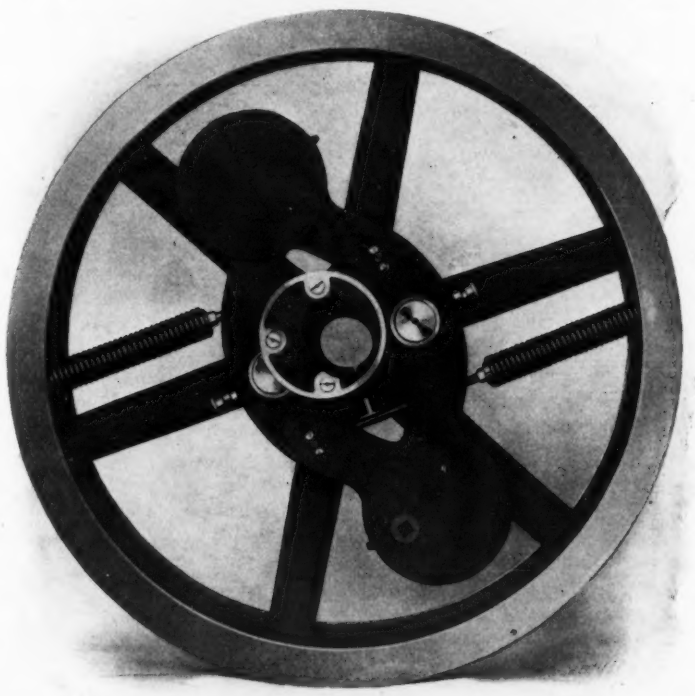


FIG. 2.—SHAFT GOVERNOR.

two weights or arms of the same section, pivoted on opposite sides of the shaft. A small amount of centrifugal force is obtained by pivoting the weights slightly out of center. The dividing line of the two weights is not at right angles with the suspension pins, this being so arranged that the governor has only the proper amount of traverse, thereby forming its own stops at both extremes of travel. The centrifugal force merely determines the speed at which the engine is run, the regulation of the speed being controlled entirely by the inertia of the heavy weights or arms, the design obviating the use of enormous spring tensions or dash pots to keep the engine steady or to prevent racing. When the engine running light or at no load is given a sudden load, the natural tendency is to slacken any speed; owing, however, to the inertia of the governor, the arms travel faster than the wheel, causing the weights to rotate on their axis, thereby causing a later cut off. When a load is suddenly released, the tendency is to increase the speed of the engine, whereupon the action of the governor causes the weights to rotate, thereby decreasing the throw of the eccentric and causing an earlier cut off. It is stated that this governor gives regulation to within one per cent. and in most instances an engine equipped with it will regain its normal speed within three revolutions of the shaft, either when full load is thrown on or suddenly released.

The cross head runs in bored guides, which are continually oiled. While it is not anticipated that this type of cross head will require any attention during the life of an engine, to meet the demands of some engineers a simple means of adjustment has been provided. The design is such that the shoe cannot leave the cross head and wreck an engine, even were it not provided with a bolt to hold it in place.

The method of lubrication is the result of a careful study of the general subject of engine lubrication. With the system adopted the lubricant is not churned, but small streams of oil are forced to all the bearings through proper channels and in such quantities that excessive heating in any reciprocating part is rendered impossible. A cylinder compound stuff box is used, which wipes all the condensation from the piston rod, which condensation is then carried out of the front of the engine frame without coming in contact with the oil. Above the pillow blocks in the engine frame is a trough which catches the oil, whence it travels in troughs on the frame of the engine to the journals; the oil also travels from this trough through a hole bored through the top of the engine frame to the center, where it flows to the cross head pin and guides. A certain amount of the oil is caught in grooves turned in the outside of the bell of the crank; these grooves are provided with holes drilled to the center of the crank pin, which, by this means, receives an abundance of oil.

Data as to Gas Generating Plant Economies.

A prominent engineer of the Power & Mining Machinery Company's staff gives the following interesting particulars concerning the economies of gas generating plants, as compared with steam plants. The yearly records of 11 electric power stations, each serving a population of 5,000 or less, and of 45 stations, each serving 5,000 or more, show:

The average B. H. P. developed	1235
The average coal consumption per B. H. P. hour	5.5 lbs.
COST OF FUEL IN STEAM PLANT (Operating 10 hours per day).	
33.96 tons coal at $4.30	$146.02
COST OF FUEL WITH GAS ENGINES AND PRODUCERS.	
7.72 tons coal at $4.30	$33.19
Saving per day	$112.83
Annual saving (365 days at $112.83)	$41,182.95

A saving of over 77 per cent. for fuel alone, paying practically 11 per cent. on the average capital invested in the above 56 plants.

The yearly record of 6 power stations of one of the largest street railway systems in America shows an average output of 15,610,934 British hp-hours per annum with a coal consumption of 2.9 pounds per British hp-hour. It is claimed that the Power & Mining system would develop this power with a coal consumption not to exceed 1¼ pounds per British hp, or, with coal at $3 per ton, to make a saving of practically $38,600 per annum on each station, or a grand total of $232,000. The producers work on hard or soft coal, wood or coke, changes from one to the other being made without interruption; a good feature sometimes, during a coal strike, for instance.

The Power & Mining Machinery Company is building in its own shops the well-known Crossley gas engine in all sizes and for all purposes. Over 55,000 of these engines are in operation, the plants in which they are employed representing the widest variety of industry. Many of these engines are to be found, moreover, in isolated and central station plants for the generation of current in large volume.

Variable-Speed Motor and 72-Inch Lathe.

A variable-speed motor is illustrated herewith in which the control is effected by varying the strength of the comparatively small current used for exciting the fields of the motor. It is shown attached to a 72-in. lathe, the motor being of 15 hp, with speeds from 350 to 1,750 r.p.m. It is being put on the market by the Ridgway Dynamo & Engine Company, of Ridgway, Pa.

The motor is of the well-known Thompson-Ryan type, in which the difficulties of shunt regulation are met by means of a special winding called "balancing coils." This device consists of a stationary winding surrounding the armature of the motor and connected in series with it. This winding has a double effect; first, it neutralizes armature reaction and prevents distortion of the magnetic field due to such reaction, and second, it builds up and maintains a commutation field of just the right strength for perfect commutation. This commutation field being produced entirely by the balancing coils, is independent of the shunt fields, and, therefore, the latter may be weakened or strengthened at will without interfering with the commutator of the motor. The armature reaction being neutralized, it does not interfere with nor distort the shunt field however weak the latter may be. It is claimed to be, therefore, possible by the use of these coils, to increase the speed of the shunt motor not only 50 per cent. but even twenty times this amount, giving a speed range of 5 to 1 or even 10 to 1 by weakening the shunt field, and still have the operation of the motor entirely satisfactory, even under full load or overload. A motor of this class, when adjusted for any particular speed, will maintain that speed approximately for all loads, which is a condition very necessary for driving machine tools. Since the torque diminishes as the speed increases, the horse-power capacity of such a motor, being the product of the torque by the speed, is constant for all speeds; this also is a condition well suited for driving tools. Again, since some of the motor losses increase with the speed and others diminish, the efficiency of the motor is practically the same for all speeds.

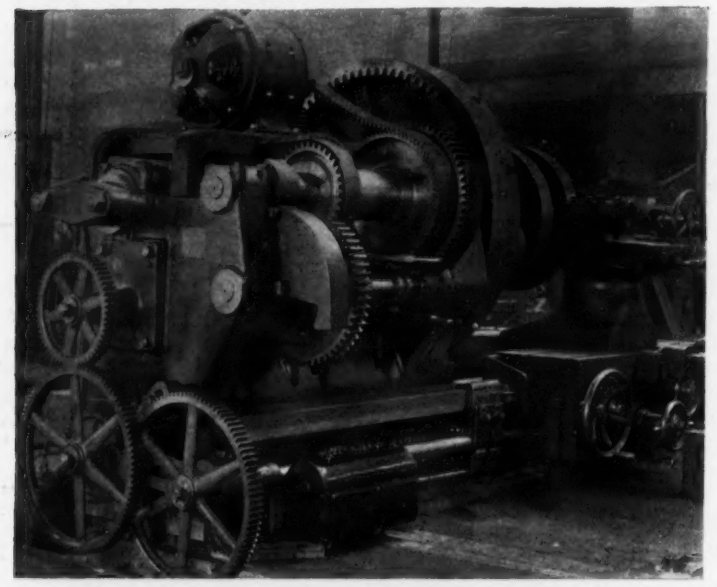


FIG. 1.—ELECTRICALLY-DRIVEN 72-INCH LATHE.

The armature of the motor is iron clad, the core being built up of thin plates of special electrical steel, mounted on a cast-iron hub or spider. The armature coils, except in the larger sizes, are form wound, of square wire, taped and insulated, and further protected by insulating boxes of oilcloth and fibre placed in the core slots. The coils are held securely in place by means of wedges driven into grooves formed in the tops of the slots. No binding wires are used over any part of the armature core. The larger-sized armatures are bar wound, with the same style of bar winding in use on the Thompson-Ryan generators for the past ten years. The field ring in the larger sizes is built of two steel castings which carry the pole pieces for the shunt field coils. Inside these pole pieces is a laminated bushing ring upon which the "balancing coils" are wound. These coils, on all motors except those of larger sizes, are form wound and easily removable from the bushing ring which carries them. In the larger sizes these coils are hand wound similar to standard dynamo construction. In the smaller sized motors, the field ring and balancing coil bushing are combined in a single laminated ring which carries both the balancing and field coils. This laminated field ring is enclosed in a cast-iron case, which also carries the bearing frames and the feet for the motor.

The brush holders are of the box type, permitting the motor to be run in either direction. The smaller motors are provided with two brushes only, placed on opposite sides of the commutator, while the larger motors have six or more. The brush holders are carried on a yoke ring, which is made adjustable so that the brushes can easily be set to their proper position. All of these motors are of the six-pole type, even to the smallest ones, and may be run in either direction without any change in the position of the brushes—a very important quality for many classes of service.

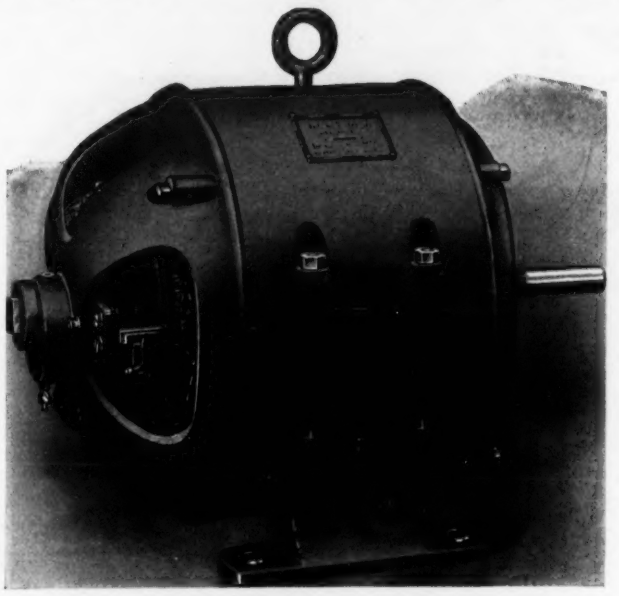


FIG. 2.—VARIABLE-SPEED MOTOR.

Controllers for these motors will vary in design according to the service to which the motor is to be applied. The manufacturers have developed a line of drum controllers especially adapted to certain classes of service, an important feature being that they are provided with short-circuiting points by means of which the motor is made to act as a brake for quickly stopping both the motor and the machine which it drives.

Induction Motors for a Pulp Mill.

The Westinghouse Electric & Manufacturing Company has sold to J. E. Henry & Sons, of Lincoln, N. H., two large induction motors for use in their pulp mill. The larger motor is a type F, rated at 600 hp, and will be supplied with three-phase current at 400 volts and 25 cycles. The motor will be direct-connected to two three-pocket pulp grinders and will run at a speed of 230 r.p.m. The smaller motor is of the type C constant-speed and is rated at 300 hp. It will also be connected to a pulp grinder and will run at a speed of 205 r.p.m. These motors are ordered in addition to a large number of machines which have been purchased from the Westinghouse Company for this paper mill. Twenty-four induction motors and four 350-kw alternators, with exciters, switchboards, transformers and detail apparatus have been ordered, and the greater part of these have been delivered.

Henry & Sons' mills have a capacity of about 80 tons per day. They manufacture news, high-grade bag and manila paper, and their mills are models of the most progressive equipment and methods. This is one of a large number of paper and pulp mill equipments which have been installed by the Westinghouse Electric & Manufacturing Company, whose experts have made a special study of this class of work and have been extremely successful. A partial list of motors ordered for these mills is as follows: One 300-hp, one 400-hp, one 350-hp, one 200-hp, one 150-hp, two 100-hp, nine 75-hp, one 50-hp, two 40-hp, one 30-hp, two 20-hp, one 10-hp and several smaller motors.

Lineman's Test Set.

The magneto is so widely used for testing out lines and electrical apparatus for continuity of circuit and freedom from grounds and crosses because it is cheap, simple and not likely to get out of order. It has, however, a number of drawbacks as it gives absolutely no idea of the resistance of the circuit other than that it is or is not greater than that through which a ring can be had with the particular magneto being used. In testing wiring in metallic conduits it will frequently indicate a ground where none exists, while two men, one to turn the crank and the other to handle the terminals, are required to make rapid readings. The instrument illustrated herewith, made by the Whitney Electrical Instrument Company, has been designed to displace the magneto tester and is claimed to have the good features of the magneto without its drawbacks.

It consists of a very simple and strongly constructed voltmeter movement mounted, together with a couple of batteries, a small rheostat and a pair of terminals, in a small, stout box of hard wood. The connections within the box are such that when the cord ends are touched together the batteries are applied direct to the voltmeter terminals, the rheostat being so adjusted that the voltmeter then shows full scale.

Evidently if a resistance were interposed between the terminals,

LINEMAN'S TEST SET.

it would be in series with the voltmeter, the needle of which would then fail to reach full scale deflection by an amount proportionate to the value of said resistance.

A table showing what number of scale divisions correspond to different resistances is secured in the cover of the box, so that in taking a reading all that need be done is to touch the cord terminals to the circuit to be tested and then read the resistance by reference to the table.

As the maximum current that can be drawn from the batteries is the exceedingly small amount required by the voltmeter, the cells may be expected to last for long periods without requiring attention. The rheostat is made adjustable from the outside by means of a screwdriver, so that even after the battery voltage has fallen off, the instrument can still be made to give full deflection on a short circuit.

The above testers are made in two ranges, one giving a readable deflection through 5,000 ohms maximum and the other through 25,000 ohms maximum.

Power Plant at Monterey, Cal.

The Monterey County Gas & Electric Company, of Monterey, Cal., has the latest installation of electrical machinery on the coast, representing the newest products of the National Electric Company, Milwaukee, Wis. This plant constituted the exhibit of Kilbourne & Clark Company, Pacific Coast agents of the National Electric Company, at the eighth annual convention of the Pacific Coast Electric Transmission Association, held in Monterey in June last, and it proved of double interest to the members of the convention who inspected it because of the fact that in it was shown for the first time on the Pacific Coast a type of machinery that had not been seen in operation theretofore, and because of its remarkably attractive and finely finished appearance, its well-proportioned designs, its high efficiency and its satisfactory operation, despite the heavy duty imposed upon it.

In detail the National machinery installed consists of a 200-kw generator and motor-generator set, consisting of a synchronous revolving-field motor of a capacity rating at 162 kw, which drives by direct coupling a National 550-volt, direct-current railway generator with a rating of 150 kw. The 200-kw generator is of the belted type, with two bearings, pulley slide rails and belt-tightening device, complete in every respect. It is of substantial construction and follows very closely the structural design that has become well established in American types of revolving-field generators. Its erected weight is 12,850 pounds, and its inherent regulation is well within 6 per cent. at unity power factor. It is run at a speed of 600 r.p.m., and consequently to deliver a current at 60 cycles is provided with 12 poles on its revolving field. The usual temperature guarantee, namely, that with an atmosphere temperature of 25° C., the temperature of the machine will not rise above 35° C. under a continuous 24-hour run at full normal load, was considerably better in that the actual rise under these load conditions was but 22° C. above the temperature of the surrounding air. In fact, it has been found to stand a remarkably heavy overload without serious heating, and in regular service it has often been called upon to operate for considerable periods of time at an overload of over 50 per cent. As to the efficiencies of the generator, they are as follows: 93 per cent. at 25 per cent. overload; 92.5 per cent. at full load; 91.25 per cent. at three-quarters load, and 88 per cent. at half load.

The exciter runs at a speed of 1,450 r.p.m., is normally rated at 12 kw, at 110 volts, and is belt-driven from a pulley placed on the end of the generator shaft. It, too, is remarkably cool in its operation, and there are no evidences of sparking or flashing at the commutator, even under conditions of extreme overload.

The motor-generator set runs at a speed of 720 r.p.m. and in operation it has been found that the temperature of the synchronous motor does not exceed 25° C. above the temperature of the surrounding air, and the direct-current generator does not exceed a rise of 25° C. in any part, when both machines are working under full load conditions.

An interesting feature in connection with the motor-generator set rests in the fact that a 22-in. pulley with a 16-in. face has been placed on the shaft between the motor and generator, and that this pulley is belted to the fly-wheel of a 200-hp, high-speed Buckeye engine. This gives absolute flexibility to the plant in that during the hours of light load both the units of the motor-generator set may be run as generators and in that the motor-generator set affords the link by means of which the railway load may be coupled in with the two-phase load, or vice versa. Obviously, this enables a day alternating-current service to be maintained in conjunction with the railway load, at maximum efficiency in operation; and, though the installation of the motor-generator set may appear anomalous in view of the fact that the current for its operation is taken from generators located on the same premises, it is regarded as the rational solution of the problems presented by the local conditions which prevail.

Warner Exhibit.

The Warner Instrument Company has an exhibit at St. Louis of cut-meters or magnetic tachometers for using with machine tools and automobiles. This meter was fully described in the ELECTRICAL WORLD AND ENGINEER of May 7. While the company's display in the space of the Northern Company is a "still" exhibit, these instruments are being used in the tests of tools made at the Exposition.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market developed great activity and strength, with heavy domestic and foreign buying after the election results were known, but eased off naturally on realizing sales. Bullish confidence, however, predominated, although standard stocks were less prominent and specialties more in evidence. The United States Steel issues showed great strength on favorable intimations about trade conditions. Industrial stocks generally inclined to show strength, a further advance in Amalgamated Copper being noted, based on the continued rise in that metal. Tractions were firm as to price, on a moderate business. Brooklyn Rapid Transit made a net gain of ¾ point, closing at 67¾, and Metropolitan Street Railway made a like gain, closing at 123⅜. Interborough Rapid Transit closed at the highest quotation of the week—155¼—a net gain of 3¼ points. General Electric reached its highest quotation of the year—181—and closed at 180, this being a net advance of 6¾ points. Westinghouse common also made the highest record of the year at 176 and closed with a net gain of 5 points, the last quotation being 176. Westinghouse preferred gained 2 points, closing at 192. Western Union showed some strength and closed at 92¾, which is a gain of 2⅛ points. American Telephone & Telegraph was the single exception in point of results and closed ¾-point minus, the last quotation being 144. Outside securities, on the "Curb" market, were active, and the volume of business was large. Following are the closing quotations of the Stock Exchange of November 15:

NEW YORK

	Nov. 7	Nov. 15		Nov. 7	Nov. 15
Allis-Chalmers Co.	13	15¼	Electric Vehicle	14	15½
Allis-Chalmers Co. pfd.	56	61	Electric Vehicle pfd.	19	21
American Tel. & Cable	93	91	General Electric.	175	180
American Tel. & Tel	143	144	Hudson River Tel.	..	..
American Dist. Tel	..	28	Interborough Rap. Tran.	152¼	155¾
Brooklyn Rapid Transit.	68¼	69⅛	Metropolitan St. Ry.	123¼	123⅜
Commercial Cable.	210	210	N. Y. & N. J Tel.	..	158
Electric Boat	38	41	Marconi Tel.	..	..
Electric Boat pfd	68	67	Western Union Tel.	91	92¼
Electric Lead Reduction	¼	⅛	Westinghouse com	170	174
			Westinghouse pfd	186	190

BOSTON

	Nov. 7	Nov. 15		Nov. 7	Nov. 15
American Tel. & Tel.	143	144	Western Tel. & Tel. pfd.	97	*101
Cumberland Telephone	118¼	..	Mexican Telephone	1¼	2⅛
Edison Elec. Illum.	246	243	New England Telephone	133	134
General Electric	174	..	Mass. Elec. Ry.	13¾	15¾
Western Tel. & Tel.	18¼	22	Mass. Elec Ry. pfd.	55	58

PHILADELPHIA.

	Nov. 7	Nov. 15		Nov. 7	Nov. 15
American Railways	49¾	49⅛	Phila. Traction	..	97½
Elec. Storage Battery	74½	75⅛	Phila. Electric	8¾	8⅞
Elec. Storage Battery pfd.	74½	75⅛	Phila. Rapid Trans.	16	18⅛
Elec. Co. of America	10	10⅞			

CHICAGO

	Nov. 7	Nov. 15		Nov. 7	Nov. 15
Central Union Tel.	..	†	National Carbon pfd.	108¼	†
Chicago Edison	..	†	Metropolitan Elev. com.	22	†
Chicago City Ry.	181	†	Union Traction	..	†
Chicago Tel. Co.	..	†	Union Traction pfd	..	†
National Carbon	38½	†			

* Asked. † No quotations received.

GAINS IN CALIFORNIA.—The California Gas & Electric Corporation has issued the following excellent comparative statement of earnings for September:

	1903.	1904.	Increase.
Gross earnings	$249,921.81	$363,653.50	$114,731.69
Oper., main., taxes, insur., and bonded int. of sub. cos.	189,436.56	276,986.97	87,550.41
Profit	59,485.25	86,666.53	27,181.28
Bond interest	33,333.33	36,458.33	3,125.00
Balance	26,151.92	50,208.20	24,056.28
Sinking fund	12,500.00	12,500.00	.....
Net surplus	13,651.92	37,708.20	24,056.28

PHILADELPHIA RAPID TRANSIT.—Advices from Philadelphia state that the head of a large local banking and brokerage house who is closely associated with the controlling interests in the Philadelphia Rapid Transit Company, confirms the statement that the greater part of the cost in building the Market Street subway, the West Philadelphia elevated lines and the Broad Street surface road would be met by a bond issue, which would be a first mortgage on the new work. There would be, he said, a call of $5 per share made, which would give the company $3,000,000 cash, and that a similar assessment would be made next year. This would make the stock $25 paid and, he thought, end the assessment feature. He saw no reason why the company could not readily float a $10,000,000 bond issue at 4 per cent., and this he is informed is the tentative programme.

DIVIDENDS.—The directors of the American Railways Company have declared a dividend of 1½ per cent., payable December 15. The directors of the National Lead Company have declared the regular quarterly dividend of 1¾ per cent. on the preferred stock, payable December 15. The directors of the International Power Company have declared a dividend of $3 per share on the preferred stock, payable January 16, 1905. This dividend is in addition to the one previously declared, payable on December 1. This makes 9 per cent. declared since October 1. American Graphophone directors have declared a dividend of 1 per cent. on the common stock, payable December 15.

COMMERCIAL CABLE.—The Commercial Cable Company is sending to its stockholders notice of a special meeting to be held in New York on November 22, 1904, to act upon the proposition to alter the company's certificate of incorporation. It is proposed to give the company power to purchase and dispose of the stock and bonds of any foreign or domestic corporation. It is also proposed to give the company power to lease or sell its property and franchises to any telephone corporation provided such lease, sale or purchase shall have been ratified by a three-fifths vote of the directors and stockholders.

NEW HAMPSHIRE TRACTION COMPANY.—R. L. Day & Co. have sold at auction $370,000 New Hampshire Traction Company 4½ per cent. first lien bonds; also 2,363 shares of the company's stock in one block for $100,000. This sale was made pursuant to the suit of the Massachusetts Construction Company, Inc., versus the New Hampshire Traction Company.

Commercial Intelligence.

THE WEEK IN TRADE.—While the election, and warm weather in some sections had a retarding effect on trade, activity is noted in the country's leading products, including iron and steel, coal, coke, hardware, hides, leather, groceries, lumber and building material. There has been an enlargement of wholesale and jobbing business and there is a firmer tone in prices. Collections are better, especially in the South, from which section relatively the best trade advices come. Railway earnings returns indicate a better distribution of the enlarged business heretofore noted by the railroads. Colder weather is needed to stimulate retail trade in most of the sections, which is, however, quite good on the whole. In the iron and steel industry more activity is noted in finished products, and pig iron is fractionally higher at all markets. Large sales of finished steel bars, plates, pipe and structural material are reported at many markets and prices are strong and tending upward. Premiums are demanded for early delivery of billets and bars. The other metals are strong, especially copper, for which there is an active demand, even at the advanced price of 14 cents. Lake ingot closed at 14.20 cents. Export demand was liberal. The number of business failures in the United States for the week ending November 10, as reported by *Bradstreet's*, was 184, against 200 the week previous and 250 the corresponding week last year.

SOME HEINE BOILER ORDERS.—The Heine Safety Boiler Company, Bowling Green Building, has just taken a contract for the boiler equipment to be installed in the power plant of the Olean (Pa.) repair shops of the Pennsylvania Railroad. There will be five units of 270 hp capacity each. The Rockford (Ill.) Edison Company has ordered two boilers of 316 hp each. The Monongahela (Pa.) Electric Company has ordered a 164-hp Heine outfit to be put in an extension of its plant and the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., has sent in a requisition for two units of 158 hp capacity each. The United States Engineers' office, at Boston, Lieut.-Col. W. S. Stanton in charge, has ordered two 150-hp boilers for Fort Warren and a similar number of 125-hp for Fort Strong.

EQUIPMENT FOR QUINTARD IRON WORKS.—Contracts are about to be placed for the equipment of a power plant to operate the Quintard Iron Works, 742 East Twelfth Street, New York City. At present Edison street current is used. The specifications call for two 60-kw and one 30-kw generators. Vertical engines will be installed on account of the small space available. Several Crocker-Wheeler motors are now utilized by the Quintard people, who will be in the market for more shortly. At present it is proposed to order but 90 kw of generators in units of 60 kw and 30 kw. Bates & Neilson, of 42 Broadway, are consulting engineers in the matter.

AMERICAN TRADE PRESS ASSOCIATION.—This growing and influential body held its fifteenth annual meeting at the Hardware Club, New York City, on November 10, when a prosperous condition was revealed by the reports, 123 periodicals now being in membership, a gain of 25 over 1903. The business meeting was followed by a banquet, and this in turn by an admirable paper by Mr. E. P. Harris on the relations of the technical and trade journal to advertising. It was followed by a brief and brisk discussion. During the evening the retiring secretary, Mr. E. C. Brown, of the *Progressive Age*, who has done splendid work for some twelve years past, was presented with a handsome set of solid silver for himself and Mrs. Brown. The new administration elected is as follows: James H. McGraw, *Street Railway Journal*, president; John A. Hill, *American Machinist*, first vice-president; F. E. Saward, *Coal Trade Journal*, second vice-president; E. C. Brown, third vice-president; secretary and treasurer, L. I. Montgomery. Directors: J. D. Cary, *Lumber Trade Journal;* Franklin Webster, *Insurance Press;* James M. Wakeman, ELECTRICAL WORLD AND ENGINEER, and F. P. Burt, *American Architect*, the last two continuing from the previous year.

SOME C & C ORDERS.—The C & C Electric Company, 143 Liberty Street, reports recent receipt of several orders for small generators for direct connection to steam and gas engines, and of the belted type. The company also states that the local demand for motors is strengthening and that the inquiries in hand, for small machine especially, are numerous. Two 100-kw, 250-r.p.m. generators arranged for direct connection to Reeves engines have been ordered for installation in the lighting plant for the new city of St. Louis Hospital. The C & C people also secured the order for the switchboard and two balancing sets. A 75-kw, also a 60-kw, 275-r.p.m. generator to be direct connected to Reeves engines have been ordered for the new Myers office building, Maiden Lane, New York City. A 75-kw, 100-r.p.m. generator is to be installed for lighting purposes in one of the large new office buildings now under construction in Philadelphia. An 85-hp, 550-r.p.m. motor is to be shipped the Bancroft & Sons Co., of Wilmington, Del., and a 40-hp special printing press equipment is an order for a Canadian newspaper plant.

LIGHTING PLANT FOR PANAMA.—The Panama-American Corporation, recently incorporated in New Jersey with a capital of $200,000 for the purpose of constructing an electric lighting plant in Panama and erecting an ice making and cold storage establishment in which electricity will play an important part, has awarded contracts for some of the initial equipment to be installed in the lighting plant and for several motors for the ice factory. The capacity of the former plant will in the first instance be 250 kw. Two 125-kw generators have been ordered from the General Electric Company, which also secured the order for the motors. The generators will be direct-connected to McIntosh-Seymour engines. The boilers, three of 126 hp capacity each, will be of Heine build. At the time of writing the pumps, condensers, piping, etc., had not been decided upon. The contracts are being placed through the export house of Isaac Brandon & Bros., of Panama and New York, local offices Bowling Green Building. Mr. John Lundie, of 52 Broadway, is the consulting engineer.

APPARATUS FOR BROOKLYN.—The Westinghouse Electric & Manufacturing Company has sold to the Transit Development Company, of Brooklyn, N. Y., a large amount of electrical apparatus, including the complete equipment of transformers, switchboards and rotary converters for ten sub-stations which will be installed by the Brooklyn company on its suburban lines. The order includes thirteen three-phase rotary converters, each being of 1,000 kw capacity, with direct-current voltage of 550; thirty-three transformers of 400 kw capacity, and twelve of 200 kw capacity. These transformers will be of the air-blast type, taking current at 6,300 volts and delivering it at about 290 volts. Complete switchboard installations will also be furnished by the Westinghouse Co. in all these sub-stations. Power from generators of the Brooklyn Heights Railroad Company will be delivered to the sub-stations at 6,300 volts, 3,000 alternations, three-phase. The contract specifies that shipment shall begin February 1, 1905, and shall be complete one year later.

SOME CROCKER-WHEELER ORDERS.—The Crocker-Wheeler Company has taken a contract for several motor-driven grinders to be shipped to the United States navy yard at Cavite, Philippine Islands. The grinders are being built by the Bridgeport (Conn.) Safety Emery Wheel Company. A 35-kw, 800-r.p.m., belted type generator and a 45-hp motor of same speed have been ordered for power use in the shops of the Locomobile Company of America. Ten Crocker-Wheeler motors, aggregating 80-hp, have been ordered by the American Match Company for its Avondale, N. J., plant. The Copper Queen Reduction Works at Douglas, Ariz., controlled by the Phelps-Dodge interests, has ordered two 60-hp, 800-r.p.m. motors. A 60-kw belt-driven engine type, 275 r.p.m. generator is to be shipped the J. B. Williams Co., of Glastonbury, Conn. Zahn & Bowley, of East Rutherford, N. J., have ordered a 22½-kw, 850-r.p.m. generator and four 10-hp motors.

CABLES SUPPLIED TO SUBWAY.—One of the features of the construction work on the New York Subway has been the amount of cable required. The American Steel & Wire Company was among the largest contractors. It has thus far furnished for the Interborough Rapid Transit Company 267,000 feet of 2,000,000 cir. mil. paper insulated and lead encased feeder cable. This cable is made up of 91 wires insulated with 5/32-inch paper, covered with lead 9/64-inch in thickness. The outside diameter of the finished cable is approximately 2¼ inches and the weight per foot of the finished cable nearly 11½ pounds. The amount of copper required in the 267,000 feet is approximately 900 tons. All of the cables tested out satisfactorily and in every way according to specification, and they are in service on the part of the road now in regular operation.

EQUIPMENT FOR WANAMAKER PLANT.—The Southwark Foundry & Machine Company, of Philadelphia, will build the engines to be installed in the power plant for the new John Wanamaker store in the Quaker City. This plant will have one of the largest isolated lighting equipments in the world. The engines will have an aggregate capacity of upwards of 5,000 hp. There will be four machines of 900 hp capacity each, direct connected to Crocker-Wheeler, 150 r.p.m. generators of 500 kw. There will also be three Southwark 600-hp engines, each arranged for direct coupling to two Crocker-Wheeler generators of 175-kw capacity each. The motors to be utilized for various purposes in the store will be of General Electric manufacture.

MICHOACAN WATER POWER CONCESSION.—Mexican advices state that a concession has been granted by the government authorities to Mr. Ernesto Brunel, of Mexico City, which permits of the utilization of water from the Zacapu River, State of Michoacan, at a point near Sabina, where a good-sized plant will be built to generate power for lighting and other purposes. The franchise is for 7,000 liters of water per second. Mr. Brunel, as a guarantee of good faith, has deposited $5,000 of 3 per cent. bonds of the Consolidated Silver Debt with the National Bank of Mexico, and work is expected to be commenced within the next month or so.

MEXICO CITY NEW TELEPHONE SYSTEM.—Advices from Mexico City state that action is expected very shortly on the plans recently submitted to the Mexican Government by the Mexican Telephone Company for installation of a new central system and placing the overhead wires underneath the central portion of the Mexican capital. As soon as the necessary authority is secured, the company will begin laying conduits and will place the contracts for the switchboard, etc. Mr. McMeen, the Chicago telephone expert, was recently in Mexico City at the invitation of the Mexican Telephone Company, with a view to preparing plans for the new system.

AMERICANS AFTER MEXICAN FRANCHISES.—American interests are seeking to obtain franchises for the construction and operation of telephone, electric lighting, traction and general power systems in and around Culiacan, a Mexican city of some 10,000 inhabitants. Mr. Oscar Braniff, whose sons represent the Westinghouse interests, is also after the lighting concession for Culiacan, and has deposited $2,000 in the municipal treasury to guarantee fulfilment of his proposed obligation.

TELEPHONE EXCHANGE EQUIPMENT.—The Kaisling protector, manufactured by the American Electric Fuse Company, has been ordered for the Independent Telephone Company, at Dixon, Ill. The new Dixon exchange will be one of the most up-to-date exchanges in the country. The Stromberg-Carlson Telephone Manufacturing Company has the contract for the equipment and has ordered the Kaisling protector for the main office. The initial installation is 1,000 pair.

GAS ENGINES FOR MEXICAN PLANT.—The Weber Gas & Gasoline Engine Company, of Kansas City, has secured a substantial contract from Señor Don Damon Corral, the Mexican vice-president-elect, for a gas engine equipment to be installed in the plant owned by Señor Corral, which generates current for lighting Hermosillo, capital of Sonora. The contract calls for four 250-hp Weber gas engines and gas producers.

J. F. SHAW & COMPANY, of Boston, have been awarded the entire contract for building and equipping a new electric railway to connect Boston and Providence, the contract price being about $3,000,000, including the cost of the large power stations. About 32 miles of new track will be required.

ALLIS-CHALMERS.—An official of the Allis-Chalmers Company states that the company's business doubled during October, as compared with September, and it is expected that November will make a relatively large showing compared with October.

General News.

THE TELEPHONE.

MOBILE, ALA.—The American Telephone & Telegraph Company is extending its line from Meridian to this city.

SELMA, ALA.—The Mapleville & Selma Telephone Company has been organized, capital $4000. Directors: N. H. Ryder, L. C. Elebash and others.

LITTLE ROCK, ARK.—The City Council has granted the Southwestern Telephone & Telegraph Company the right to construct an underground conduit system in certain streets of this city.

COLORADO CITY, COL.—The El Paso Telephone Company has been established with a capital of $500,000. M. H. Spere, N. B. Hames and others are the incorporators.

DUNWOODY, GA.—Dr. J. W. Puckett has sold his telephone line from here to Roswell to the Bell Telephone Company, which will operate the line from Chamblee to Roswell. The Bell Company will put in a switchboard at Dunwoody, Dr. Puckett having charge of it. The company is pushing the line on to Dunwoody.

QUINCY, ILL.—The Quincy Automatic Telephone Company has been granted a franchise for a telephone system in Quincy. About five miles of conduit will be built early next spring. The president of the company is Jackson R. Pearce, of Quincy.

MANSFIELD, ILL.—At a meeting held by the Mansfield Mutual Telephone Company the following officers were elected: Howard Nash, president and secretary; John Churchill, Chas. Gordon and Samuel Howe, directors, and W. H. Burns, treasurer.

CHICAGO, ILL.—A committee of nine aldermen has been appointed to handle questions arising between the city and the Chicago Telephone Company. At present matters concerning toll charges, excessive switchboard charges and back compensation from annexed towns are in dispute.

FORT WAYNE, IND.—The National Telephone & Telegraph Company of West Virginia, capitalized at $250,000, has been admitted to the state. William L. Moellering, of Fort Wayne, is agent of the company.

CHANDLER, IND.—The Chandler Telephone Company, which was recently incorporated with a capital stock of $2500, will build a local exchange and operate telephone lines throughout the country. The chief organizers of the company are W. M. Gardiner, W. M. Cosler and J. W. Webb.

ROCKWELL, IA.—The Rockwell Telephone Company has been incorporated with a capital stock of $25,000 by E. N. Egge and others.

WHITEWATER, KAN.—The Whitewater Telephone Company has been formed with $15,000 capital.

PEKIN, KAN.—The Pekin Telephone Company has been chartered with $4500 capital stock.

NORTHAMPTON, MASS.—The New England Telegraph & Telephone Company will let the contract at once for a new telephone exchange.

CADILLAC, MICH.—The Citizens' Telephone Company has decided to extend its lines to Meauwataka, Boon and Henrietta. Construction work will be started shortly and it is expected that the system will be in operation in three villages before the first of next year. A large number of farmers' lines will be installed.

ST. LOUIS, MO.—The Bell Telephone Company has leased the lot of ground on the northeast corner of Tenth and Pine Streets and will erect thereon for its own use an office building of ten or twelve stories high. The Bell Company's Olive Street building will be refitted up and used exclusively for exchange purposes when the proposed structure is completed.

JOHNSONVILLE, N. Y.—The Johnsonville Telephone Company has been incorporated with a capital stock of $500. The incorporators are J. D. Van Wirt, G. I. Haner and E. H. Abbott, of Johnsonville.

LINCOLN, NEB.—The Archer Independent Telephone Association has been incorporated with a capital stock of $50,000 and a paid-up capital of $900. A. J. Harshberger, J. B. Templin and others are the incorporators.

GREENSBORO, N. C.—The Southern Bell Telephone Company and the citizens of Greensboro, N. C., have about settled all differences as to rates. A committee of five will be selected to hear all complaints against the telephone company hereafter.

LORAIN, OHIO.—The Bell Telephone Company announces that it will put up a $15,000 building here.

NEW LYME, OHIO.—The New Lyme Telephone Company has been incorporated by M. A. Smith, F. F. Fitch, Frank Bishop, W. H. Reeve and C. H. Coon.

FINDLAY, OHIO.—The Farmers' Mutual Telephone Company has established a new toll line from McComb to Belmore and is now connecting central with the Van Buren line by cable.

NEW LEBANON, OHIO.—The New Lebanon Telephone Company has been incorporated with a capital stock of $10,000. The incorporators are D. C. Mills, V. E. Weaver, G. C. Smith, G. M. Hepner and S. P. Diehl.

CHESTER HILL, OHIO.—The Chester Hill-Brown's Mill Telephone Company, Chester Hill, has been incorporated by Fred M. Inturf, Ed. Hopkins, H. S. Hopkins, John M. Russell and T. J. Edgerton.

MARIETTA, OHIO.—A new telephone company has been organized to be known as the Caldwell-Marietta Telephone Company, with a capital stock of $25,000. The directors are A. L. Gracey, W. H. H. Jett and others.

PLAINGROVE, PA.—The Plaingrove Telephone Company has been organized with a capital stock of $5000. Directors: J. B. Humphrey, N. A. Offutt and others.

LEXINGTON, S. C.—The Lexington Telephone Company has been incorporated with $1000 capital. Mr. J. E. Kaughman is president.

BROWNWOOD, TEX.—The West Texas Telephone Company, has been incorporated with a capital stock of $100,000. The incorporators are C. C. Woodward, J. A. Walker, H. T. Williams, N. H. Hollingsworth and G. N. Harrison, all of Brownswood and N. R. Conroe, of Goldthwaite, Texas; R. G. Hollingsworth, of Coldman, Tex.

ELECTRIC LIGHT AND POWER.

BRINKLEY, ARK.—The Farrell Light, Heat & Water Company, of Brinkley, has been incorporated; capital, $50,000. J. J. Farrell is president and W. S. Kilpatrick, secretary.

RIALTO, CAL.—A committee of the Rialto business men has asked the San Bernardino Gas & Electric Company, of San Bernardino, to extend its lines to Rialto for lighting and power purposes.

FORTUNA, CAL.—The Fortuna Lighting Company has been incorporated with a capital of $60,000. Directors: L. M. Hancock, Denver Sevier and D. S. Newell. The new company is the successor to the plant of the Humboldt Milling Company, of Fortuna, and also the franchise of the latter for the extension of electric light and power lines into the adjacent townships.

SAN FRANCISCO, CAL.—The Territorial Government of Hawaii recently awarded contracts for equipment for the new municipal electric lighting plant for the city of Honolulu. The streets and public buildings will be lighted from this source, but commercial lighting will not be engaged in. The contract for 140 alternating series arc lamps and regulating apparatus was secured by the General Electric Company's representative, the price being a little less than $6000. The Hawaiian Electric Company, agent for the Westinghouse Electric & Manufacturing Company, secured the contracts for the remainder of the equipment, including generator exciters, switchboards and transformers. The 200-kw, 3-phase generator will have an e.m.f. of 2300 volts. The current will be distributed at the initial voltage. The Westinghouse O. D. transformers ordered are in small sizes from No. 1 to 10.

SAN FRANCISCO, CAL.—The Truckee River General Electric Company has closed ten-year power contracts with all of the 32 mining companies composing the Comstock Pumping Association. The principal use of the power will be for electric pumping, although hoists and mills will also be operated. Plans have been prepared by Engineer A. M. Hunt for a second electric generating station to be located at the extreme eastern end of the Truckee General Company's hydraulic system. Water, taken from the Truckee River, will be dropped 141 feet, the water wheels being direct connected to polyphase generators. The initial installation will include one 1500-kw generator, provision being made for increasing the equipment as business grows. The new pole line will extend 32 miles from the plant, near Floriston, Cal., to Virginia City, Nev. The present generating station is equipped with two 750-kw generators supplying all of the electric power now used on the Comstock Lode. Under the present contract the rate paid by the mining companies is based on the "peak" load, but the new contract is based on the actual amount of electric power used, with a rising scale of prices as the amount of power used per month diminishes. If 5000-hp—the maximum amount of power named in the new contract—is used by the mining companies, the rate is to be $4.50 per horsepower per month. This would effect a considerable saving for some of the companies. The rate for 1000 horse-power or less is $6 per horsepower-month and for 1250 horse-power, $5.50. The Comstock Pumping Association has excavated a large chamber, connecting with the Ward shaft, for the reception of an additional electric pumping plant, which will supplement the present Reidler pumps in draining the lower levels of the Comstock. Bids for 800-hp induction motors have been received from nine different electric manufacturing concerns and contracts will be awarded at once. The motors will be geared to the double duplex pumps, which are required to raise 3200 gallons of water per minute from the 3100-foot level to the Sutro tunnel, through which the mines will be drained. Leon M. Hall, of San Francisco, is engineer for the Comstock Pumping Association.

NEW CASTLE, DEL.—The City Council has granted the Delaware Water & Improvement Company a 25-year franchise to construct and operate water works and an electric light plant.

CAMILLA, GA.—The town of Camilla has voted $25,000 for a water and lighting plant.

NEWMAN, GA.—An election was carried in favor of bonds for the purchase of the Newman Light & Power Company's plant, to be operated by the city of Newman.

McHENRY, ILL.—The McHenry Light, Heat & Power Company has incorporated with a capital of $20,000. Incorporators: Stephen Reynolds, Dewitt C. Doe and Wm. D. Ball.

HAGERSTOWN, IND.—Howard Hunter is interested in the construction of an electric light plant.

SIOUX CITY, IA.—An ordinance has been passed granting Edward Tilden and Samuel McRoberts the authority to erect, maintain and operate here an electric light plant.

MANSFIELD, ILL.—The Mansfield Electric Company has been incorporated with a capital of $10,000 to build an electric light and power plant. The incorporators are E. E. Saylor, R. E. Howe and C. W. Fiske.

DANVILLE, KY.—F. T. Snyder has received a franchise to build an electric light plant for Danville and an electric railway from this city to connect with the L. & N. and Junction City.

PLAQUEMINE, LA.—Victor M. Garber, of Shreveport, has secured a franchise for an electric light and power plant.

SOUTH WINDHAM, ME.—The town of Windham has granted to the Mallison Falls Electric Light & Power Company permission to extend its wires through South Windham, for commercial lighting purposes.

AUGUSTA, ME.—The Wilton Electric Light & Power Company, already chartered, has been organized at Wilton, with a capital stock of $10,000, of which nothing was paid in at the time of organization. The president is A. B. Adams and the treasurer is ex-Senator C. N. Blanchard, both of Wilton. R. C. Fuller, F. J. Goodspeed, of the same town, are the directors.

BALTIMORE, MD.—The fight between the Maryland Telephone & Telegraph Company and the United Electric Light & Power Company, which was begun before the City Council last spring, when the former asked for permission to put its wires in the city's subways for the purpose of engaging in the electric lighting business, has been taken to the courts. In a suit filed a few days ago by Mr. Alexander Brown, as a stockholder of the Maryland Telephone Company, he denies the right of that company to engage in the electric lighting business under its charter, and asks that it be restrained from using the money of the stockholders for that purpose.

LENOXDALE, MASS.—The Washburn Electric Company has been incorporated, with a capital of $6000 by W. H. Washburn, L. H. Hubin and T. E. Moat, of North Adams, to develop the water power and to light the streets and public buildings by electricity.

BENTON HARBOR, MICH.—It is stated that plans have been perfected by Chas. A. Chapin and his water power company which proposes transmitting electrical power from the dam at Buchanan to the twin cities.

NEGAUNEE, MICH.—The Negaunee & Ishpeming Street Railway & Electric Company proposes increasing the capacity of its electric light plant by the addition of two 180-kw 2300-volt, 60-cycle machines, also an engine.

EAST GRAND FORKS, MINN.—W. J. Murphy, of Minneapolis, is interested in constructing water works and a lighting plant here.

ST. JOSEPH, MO.—The plans of Architect Benj. Trunk have been accepted for the building for the municipal electric light plant. It will cost $12,000.

OXFORD, MISS.—Bids are wanted Dec. 5 for the construction of an electric light plant. R. S. Adams is Mayor.

HAVRE, MONT.—The plant of the Havre Electric Light & Telephone Company has been sold to Turner & Hebgen, of Butte, who are remodeling the plant and will install new machinery and double its present capacity.

KALISPELL, MONT.—Jeremiah Miller and others have formed the Montana Water Power & Electric Company, with a capital of $2,000,000, to construct a power plant and trolley line.

ASHLAND, NEB.—The Ashland Light, Mill & Power Company has been incorporated, with a capital of $15,000, by C. H. Brown, J. C. Ralsbock and F. E. White.

CONCORD, N. H.—The Troy & Fitzwillian Light & Power Company has been incorporated with a capital stock of $15,000.

CONCORD, N. H.—Articles of incorporation have been filed with the Secretary of State by the Nebraska Lighting Company of Concord, capital stock $100,000. The incorporators are Samuel C. Eastman, L. C. Merrill, William P. Fiske, Ernest P. Roberts and L. P. Elkins. The company's property is located in the west.

FILLMORE, N. Y.—The Genesee Valley Power Company has been organized by George Forbes, of Olean, and W. L. Young, of Fillmore.

ONEIDA, N. Y.—Bids will probably be received about Jan. 1 for the construction of an electric power plant at Limekiln Falls, to cost about $125,000. D. C. Hadcock, of Oneida, can give information.

BROOKLYN, N. Y.—Bids will be received Nov. 23 by Geo. E. Best, Commissioner of Bridges, New York City, for furnishing and installing two 120-hp steam engines and two 75-kw direct-current generators at the Brooklyn Bridge power house.

TANNERSVILLE, N. Y.—The Schoharie Light & Power Company has been incorporated with a capital stock of $40,000. The directors of the company are C. E. Hewitt and M. G. Hubbard, of Chatham, N. J., and H. A. Heyn, of New York City.

WHITEVILLE, N. C.—The town of Whiteville is preparing to install a lighting plant, using power from a local manufacturing plant.

ASHEVILLE, N. C.—The Piedmont Electric Company, of Asheville, has the contract for a 300-light system at Mineral Bluff, Ga., for the Blue Ridge tannery, also for a 650-light plant to be run in connection with a new cotton mill at Marshall, N. C., to light the town.

CHESTERHILL, OHIO.—The Chesterhill Fuel & Light Company has been incorporated with a capital of $16,000, by Wm. Haines, Osborn Smith, Cecil D. Laing and others.

HOBART, OKLA.—The Hobart Light & Power Company has been incorporated by J. H. Carter, George Seldon and others. Capital, $50,000.

GUTHRIE, OKLA.—The Guthrie Electric Light & Power Company has been incorporated with a capital of $150,000 by Thos. H. Smith, of Denver, and J. R. Cottingham and U. C. Guss, of Guthrie. The new company has acquired the stock of the Electric & Gas Light Company, which is to be merged into the Guthrie Light & Power Company. The plant will be enlarged.

DALLAS, ORE.—The Dallas Light & Power Company, of Dallas, has been incorporated with a capital of $1000 by Harry V. Gates, D. P. Stouffer and others.

PITTSBURG, PA.—The councils here have been asked to grant a franchise which will permit another company to engage in the electric light business in competition with the Allegheny Electric Light Company.

PHILLIPSBURG, PA.—The electric light company has secured the contract for lighting the streets by electricity for a term of 5 years at $80 per light per year, and $10 per light per month for the borough buildings.

PITTSBURG, PA.—Mayor W. B. Hays has signed the ordinance granting a franchise to the Duquesne Light Company. An electric light plant will be constructed at once. Robt. C. Hall is president and S. P. Austin, secretary.

CHARLESTON, S. C.—The Secretary of State has issued a charter to the Broad River Light & Power Company, of Charleston, with a capital of $1,000,000. The company will construct a power plant on Broad River at Lockhart Shoals.

McCORMICK, S. C.—A party of New York capitalists have recently investigated the water power on the Savannah River, near McCormick, S. C., and surveys are being made. In the party were D. M. Mackay, and Dr. F. A. C. Perrine, of New York; C. M. Knight, of Brooklyn, and L. F. Dorn, of Parksville.

LANCASTER, S. C.—At a special election, Oct. 25, the voters confirmed the franchise for water and electric lights recently granted to Col. T. Y. Williams, of Lancaster.

UNION, S. C.—The Broad River Light & Power Company, with $1,000,000 capital, has been commissioned with headquarters at Union, where it is proposed to develop a water power on Broad River. The incorporators are mostly from Charleston, S. C., and includes J. H. Dingle, F. K. Myers, M. V. Haselden and others.

CHATTANOOGA, TENN.—The Chattanooga Electric Company has secured the contract for lighting the city for 5 years, its bid being for arc lights $6.49 per month for each light, or $77.89 per year. The total cost per year is $17,600.

JACKSON, TENN.—The Jackson & Suburban Street Railway, which operates an electric light plant, has served an injunction against the City Council passing an ordinance granting a street franchise to the Jackson Electric Light Company, a new organization. The old company claims an exclusive franchise.

STOUGHTON, WIS.—The citizens have voted to issue bonds for a municipal electric light plant.

MILWAUKEE, WIS.—According to A. F. Wardlaw, of the R. W. Hunt Company, of Chicago, which is preparing estimates on the cost of a municipal electric lighting plant for this city, the plant alone could be built for $175,000. For laying of conduits and other outside work $325,000 additional would be required. These figures are for a plant supplying 2000 enclosed arc lamps at an estimated cost of $50 per year each.

THE ELECTRIC RAILWAY.

NAPA, CAL.—An ordinance has been adopted granting to the San Francisco & Napa Railway Company a franchise for constructing and operating electric railways and telephone and telegraph lines along certain public highways in Napa County.

SAN FRANCISCO, CAL.—A special meeting of the stockholders of the Columbia Electric Company of California has been called for Dec. 27, 1904, to vote upon a proposition to create a bonded indebtedness of $3,000,000 in 30-year 5 per cent. bonds, interest payable semi-annually. This company was recently incorporated in San Francisco, being practically a re-incorporation of the Stanislaus Power Company. After the latter company was incorporated its directors were informed by the State authorities that another corporation of the same name was in existence in California, and a change of name was necessitated. Sidney Sprout, the electrical engineer, is one of the members of the new company. The proposed water power electric plant will probably have a capacity of 20,000 horse-power, with units of 4000 or 5000 kilowatts, 25 cycles. It will take about two years to complete the installation in Stanislaus County after the exact site of the power station is decided upon.

SAN FRANCISCO, CAL.—It is reported on good authority that the equipment of the North Beach electric power station of the United Railroads of San Francisco is to be increased by the addition of three 4000-hp Snow gas engines, each to be direct connected to a three-phase generator. It is understood that under an agreement between the United Railroads and interests allied to the California Gas & Electric Corporation high efficiency gas engines are to be installed, making 12,000 horse-power available for the operation of electric cars. This is in addition to the present capacity of the station, which is 8000 horse-power. General Electric generators are now operated by Union Iron Works triple-expansion engines. It will be necessary to erect large gas works, using the Lowe Crude Oil Gas process to supply the new gas engines. One object in installing the new equipment is to provide a relay or reserve station for the Standard Electric transmission line which is owned by the California Gas & Electric. Although no current is being distributed from the Standard sub-station in San Francisco at present, a sub-station is being constructed in South San Francisco, where electric power will be supplied for manufacturing and lighting purposes. The United Railroads will thus be assured a sufficient supply of power when the new engines have been installed and the California Gas & Electric interests will be in a position to sell gas for power purposes. It has not been ascertained whether or not gas and electric power will be distributed throughout the city on a commercial basis. With the supposed object of furthering the new enterprise the Realty Construction & Financial Company has been incorporated with a capitalization of $200,000, by representatives of both the United Railroads and the California Gas & Electric Corporation. The incorporators are John A. Britton, general manager of the California Gas & Electric Corporation; Arthur P. Holland, president of the United Railroads; F. J. Amweg, engineer and general manager of the American-Hawaiian Engineering & Supply Company; Walter Morgan and John Parker Cotton.

FORT COLLINS, COL.—The City Council has passed an ordinance giving the Northern Colorado Electric Railway Company the right to build an electric railway along the business streets of the city.

NEW LONDON, CONN.—It is said here that the contract for building the East Lyme Street Railway has been awarded to M. W. Burwell, of New Haven, who will not only build the road, but will also furnish the cars and equipment.

HARTFORD, CONN.—Options are being offered in New Haven on the valuable water power recently completed at Bulls Bridge, above New Milford, on the Housatonic. The company furnishes electric power to the Connecticut Railway & Lighting Company under a thirty-years' contract. The possible

customers are said to be the Railway & Lighting Company, the brass people of Ansonia and the New York, New Haven & Hartford road.

WASHINGTON, D. C.—The Washington Railway & Electric Company is at work on plans to greatly improve the service and much new machinery has been ordered, part of the new equipment having been purchased at the St. Louis Exposition.

EAST ST. LOUIS, ILL.—The capital of the East St. Louis & Suburban Railway Company has been increased from $3,000,000 to $3,300,000.

CHICAGO, ILL.—Chicago capital, represented by Attorney John M. Duffy, it is said, has secured control of $1,000,000 stock of the Detroit, Flint & Saginaw Interurban Railway. The company now operates 16 miles of road through Saginaw to Frankenmuth. The road, it is stated, will be extended to Flint.

CHICAGO, ILL.—Efforts are being made to have the Council reconsider the ordinance granting the Northwestern Elevated the right to extend to Ravenswood. The ordinance which was passed by the Council included some burdensome provisions which had nothing whatever to do with the proposed extension. The result was that the company refused to accept the ordinance. Petitions are now being circulated in the districts through which the extension would run asking the Council to pass an ordinance leaving out these objectional requirements.

PRINCETON, IND.—The Pocket Interurban Railway Company has been organized to build electric railway lines from Princeton to nearby towns. Jasper Davidson has been selected as president of the company, and I. E. Criswell as secretary.

TERRE HAUTE, IND.—The several companies owning the electric properties of the Stone & Webster syndicate, of Boston, have been merged into the Terre Haute Traction & Light Company, with a capital stock of $3,000,000. The charter gives it authority to build traction lines to several towns in Indiana and Illinois.

INDIANAPOLIS, IND.—The Indianapolis, Logansport & South Bend Traction Company, of Indiana, has filed articles of incorporation. The initial capital stock is $10,000, and the directors are J. M. Caulfield, George H. Leslie, S. S. Perley, Edmund Taylor and V. S. Nicar, of South Bend; J. J. Greene, of Notre Dame; A. F. Surgait, H. J. Crimrod and J. G. Powell, of Logansport.

WEBSTER CITY, IA.—The business men and capitalists of Webster, Hamilton and Hardin Counties have been considering plans for the organization of a company to construct an electric railway from Fort Dodge to Iowa Falls. The electric line will be about 55 miles in length.

HAGERSTOWN, MD.—The Hagerstown Street Railway Company will, it is stated, extend its system from Boonsboro to Sharpsburg and Antietam battlefield probably this winter. The new line will be 6 miles in length and traverse a fertile and populous section of the country.

BOSTON, MASS.—The Railroad Commissioners are considering a petition of the Leominster, Shirley & Ayer Street Railway for permission to issue original capital stock amounting to $100,000, the same to be used in payment of expense of constructing the road.

BAY CITY, MICH.—The Detroit & Bay City Traction Company's franchise was granted by the Council here Oct. 24, and accepted by the company.

GRAND HAVEN, MICH.—The Board of Supervisors has granted a franchise to the Riverside Electric Railway Company to run its road through the county.

LACONIA, N. H.—R. L. Day & Company have sold at auction $370,000 New Hampshire Traction Company 4½ per cent. first lien bonds; also 2363 shares of the company's stock in one block for $100,000. This sale was made pursuant to the suit of the Massachusetts Construction Company, Inc., vs. the New Hampshire Traction Company.

DURHAM, N. C.—The Durham Traction Company has made a proposition to build a 12-mile electric railway to Chapel Hill, N. C., if the citizens of the latter place will petition the legislature to abolish the present steam line. The proposition is said to be favored by the town of Chapel Hill.

ASHEVILLE, N. C.—The franchise and right-of-way of the Asheville & Weaverville Electric Railway has been transferred to John D. Miles, of Warsaw, Ind., and it is said work will begin shortly on the ten-mile line.

GRAHAM, N. C.—The Allamance Street Railway Company has been incorporated, with offices at Graham. It is stipulated in the articles of agreement that the company shall have authority to construct and operate street railways anywhere in the State. The company has an authorized capital of $25,000, and the incorporators are J. L. Williamson, J. W. Cates and J. W. Minefree.

PALMYRA, N. Y.—The contract for building the Rochester, Syracuse & Eastern trolley road from Palmyra to Lyons has been let to J. G. White & Company.

YOUNGSTOWN, OHIO.—A company has obtained a franchise at Greenville, Pa., for a line from that place to Sharpesville, Pa., where connection will be made with the Youngstown & Sharon Railway for Youngstown.

CINCINNATI, OHIO.—A party of prominent financial men recently made an inspection of the route of the proposed Chester Park, Norwood & Redbank Belt Line. The promoters expect to build an electric belt line connecting several suburbs of Cincinnati.

MARION, OHIO.—A meeting of the directors of the Marion-Bucyrus Railway & Light Company is to be held within a few days to confirm a proposition for placing the bonds with a New York company, also for placing a contract for the building of the road. G. A. Bartholomew, of Cleveland, one of the promoters, states that all arrangements necessary for building will undoubtedly be arranged, and that the road will be built in the spring.

LIMA, OHIO.—The stockholders of the Fort Wayne, Van Wert & Lima Traction Company have decided to erect a large power station near Fort Wayne, Ind., with which to supply the entire road. At present the road is in operation between Lima and Delphos and power is purchased from the Western Ohio Railway Company's station at St. Marys.

COLUMBUS, OHIO.—The Columbus Northern Railway, Power & Equipment Company, of Columbus, capital stock $300,000, has been incorporated by John G. Weeb, George Whysall, Walter A. Block, James S. Weeb and Oscar Gottschall. The incorporators are officials of the Columbus, Delaware & Marion Railway Company. The new company will erect a large power house near Delaware to supply the electric railway with power; also to supply light, heat and power in Delaware. At the present time the road is supplied by three direct-current power stations. It is the intention to erect sub-stations and transmit at high voltage.

OKLAHOMA, OKLA.—At the reorganization of the Oklahoma Gas & Electric Company, Oct. 20, the following officers and directors were elected: C. B. Ames, Oklahoma City, president; H. M. Byllesby, Chicago, vice-president; D. T. Flynn, Oklahoma City, secretary; A. H. Grimes, Guthrie, treasurer; Rufus C. Dawes, Chicago, Samuel Insull, Chicago, H. M. Newton, Sparta, Wis., directors. R. J. Graf, Chicago, was appointed assistant secretary and treasurer. H. M. Byllesby & Company were retained as engineers for the property.

PORTLAND, ORE.—Articles of incorporation of the Portland Consolidated Railway Company, the final step in the consolidation of the Portland Railway Company and City & Suburban lines, were filed in the County Clerk's office a few days ago by A. L. Mills, J. C. Ainsworth and C. A. Dolph; capital stock $5,000,000.

YORK, PA.—The York County Traction Company's engineer corps has been at work making a survey for the proposed new electric railway that will ultimately connect York with Logansville and Glen Rock with the suburban electric railway system. The new line will probably branch off from the Dallastown line near Spry, and will run through Paradise, thence to Logansville, and thence to Glen Rock.

GREENSBURG, PA.—The Jeannette, West Newton & Monongahela Street Railway Company has organized as follows: J. C. Cribbs, president; W. H. Van Valin, vice-president; W. F. Euwer, treasurer; Alf. T. Smith, secretary; Rev. J. M. Bauman, W. A. Cribbs, Dr. N. J. Baxter, Frank Barnhart, D. W. Jenkins, J. C. Cribbs, W. H. Van Valin, W. F. Euwer and Aff. T. Smith, directors. A preliminary survey of the proposed road has been made and practically all the rights of way have been secured.

BRISTOL, PA.—The connecting of the two ends of the Philadelphia, Bristol & Trenton Street Railway tracks at the Andalusia Bridge closes all but one of the gaps existing between Morrisville, opposite Trenton, and the lines running into and through the city of Philadelphia. There is a break at this place, where the line meets on opposite sides of the Pennsylvania Railroad tracks, but this will be closed as soon as the steam railroad elevates its tracks. With this route and the one which will be afforded by the New Jersey & Pennsylvania Traction Company's extension to Willow Grove, it will be possible for the Philadelphia Rapid Transit Company to run cars through to Trenton over one route and back over another.

SALT LAKE CITY, UTAH.—Barney Mahler, of Cleveland, who has been here several months in the interest of a proposed suburban line out of this city, secured all the franchise he desires save at Ogden and Salt Lake City.

MILWAUKEE, WIS.—The survey of the proposed route of the Wisconsin Rapid Transit Company between Fon du Lac and the city limits of Milwaukee has been completed. C. D. Smith, of Fon du Lac, is interested in the scheme.

OSHKOSH, WIS.—The Westinghouse Electric & Manufacturing Company is getting out the plans and specifications and estimates for the complete electrical equipment and construction of the new electric railway 22 miles long to be built between Omro and Berlin for a through interurban line from Oshkosh to Berlin. Plans are understood to provide for the single-phase system, motors and equipment to be of the latest interurban pattern, with convertible coaches and express cars for handling local package freight and produce. Within the last few days the articles of incorporation of the road were filed with the Secretary of State at Madison of the Oshkosh & Western Electric Railway Company to build a freight and passenger line from Oshkosh to Berlin, with capital of $10,000. The incorporators are J. H. Porter, Clement C. Smith, George Hilton and C. S. Morris.

NEW INDUSTRIAL COMPANIES.

THE MUTUAL ENGINEERING COMPANY, of New York, has been incorporated with a capital stock of $5000. The incorporators are J. B. Smith, William Horton and Percy Leonard, of New York.

THE KEELYN ELECTRIC COMPANY, of Milwaukee, Wis., has been incorporated with a capital stock of $15,000. The names of the incorporators are Peter R. Keelyn, Benjamin Burdick and Henry Schwendener.

THE INTERNATIONAL CURRENT POWER COMPANY, of Buffalo, N. Y., has been incorporated with a capital stock of $100,000. The directors are Henry Lewis, Edward Delahunt and Thomas MacDonald, of Buffalo.

THE ANCK ELECTRIC COMPANY has been incorporated at Philadelphia to manufacture electric lamps, with a capital stock of $250,000. The directors are John M. Anck, John S. Carter, Wm. Anck, all of Philadelphia, Pa.

THE W. C. JONES ELECTRIC CONSTRUCTION COMPANY, of Geneva, N. Y., has been incorporated with a capital stock of $1000. The names of the incorporators are Wm. C. Jones, Henry Renter and Wm. H. Glover, of Geneva.

THE L. M. ERICSSON TELEPHONE MANUFACTURING COMPANY, of Tonawanda, N. Y., has been incorporated with a capital stock of $200,000. The directors are Axel Bostrom, Stockholm, Sweden, and F. M. Parke and C. H. Smith, of Buffalo.

PERSONAL.

PROF. A. E. DOLBEAR, of Tufts College, is expected to give a lecture on Wireless Telegraphy before the Daughters of Massachusetts at the December meeting of the club in Boston.

PROF. HARRY E. CLIFFORD, acting head of the department of electrical engineering in the Massachusetts Institute of Technology, has been appointed to the free professorship of theoretical electricity in the institute.

MR. W. S. BARSTOW has been elected a member of the faculty of the Polytechnic Institute of Brooklyn. Mr. Barstow will serve in the department of electrical engineering as consulting professor of central station practice.

MR. CHARLES F. SCOTT has become a member of the board of consulting professors of the department of electrical engineering in the faculty of the Polytechnic Institute of Brooklyn. He will give instruction concerning engineering in a large electric company.

MR. J. B. PARSONS.—President John B. Parsons, of the Philadelphia Rapid Transit Company, has returned from Europe and says Philadelphia will have the finest elevated road in this country. It is to be constructed with a solid roadbed, like those in Paris and Berlin.

MR. CHARLES LANG, formerly with the Wheeler Condenser & Engineering Company, has joined the sales department of the A. D. Granger Company, at the New York Office, 95 Liberty Street. Mr. Lang will make a specialty of pumps and condensers, the Granger Company having recently acquired the agency for the Barr Pump Company, of Philadelphia, Pa.

MR. THOMAS D. LOCKWOOD, head of the patent and technical information bureau of the American Telephone & Telegraph Company, and advisory electrician for the Western Electric Company and for the Bell Telephone Company of Canada, has joined the faculty of the Polytechnic Institute of Brooklyn as consulting professor of telephony, telegraphy and patent practice.

DR. LOUIS DUNCAN has become a member of the faculty of the Polytechnic Institute of Brooklyn, as consulting professor of electric traction. His pedagogical experience, formerly as organizer and head of the department of electrical engineering at Johns Hopkins University, and recently as reorganizer and head of the department of electrical engineering at the Massachusetts Institute of Technology, eminently qualifies him for this position.

DR. F. A. C. PERRINE has become a member of the faculty of the Polytechnic Institute of Brooklyn. Dr. Perrine will affiliate with the department of electrical engineering as consulting professor in long distance electric power transmission. Dr. Perrine's long experience as chief engineer of the Standard Electric Company, of California, which company operates the longest electric transmission lines in the world, especially fits him for the position.

MR. EDWIN R. WEEKS contributes to the *Kansas City Journal* a very interesting article on the work that the Humane Society has done there. During the past 20 years, 12,521 cases of brutality to children and 28,166 cases of cruelty to animals have been dealt with at a cost of $24,000. In all there have been 74,397 visitations of mercy by the society—a splendid record in which Mr. Weeks, who has contributed so greatly toward it, is justified in taking pride.

MR. CYRUS ROBINSON is ill with typhoid fever at his home, at Mount Vernon, N. Y. Mr. Robinson, who is a well-known authority on the economical use of fuel, has in connection with his duties as vice-president of the Power & Mining Machinery Company, taken an active part during the last two years in the development of gas generating plants. His illness is probably traceable to overwork, and we join with his many friends in hoping for his speedy recovery.

MR. PERCIVAL G. BURGESS, for many years general manager of the Mexican Telephone Company of Mexico City, whose system is to be considerably remodeled and extended, has resigned his position, owing to ill health. He will be succeeded by Mr. Samuel Judson, who for the past two years has acted as assistant manager. Mr. Judson was at one time connected with the Chicago Telephone Company, the Union Central Telephone Company and the Wisconsin Central Telephone Company.

MR. F. A. STRATTON.—The directors of the Westchester Lighting Company, capitalized at $22,500,000, held a meeting last week and promoted F. A. Stratton, of Mount Vernon, to the position of president. Mr. Stratton has served as vice-president of the corporation for six years, during which he has extended its electric and gas plants to 22 cities and towns in Westchester County and the Bronx. It is said that the directors have under consideration extensive improvements in outlying territory, which involve the expenditure of several hundred thousand dollars.

PROF. MIABI.—The first meeting of the winter of the Worcester branch of the Worcester Polytechnic Institute Alumni Association was held on the evening of October 25 at the new Bay State Hotel, Worcester, Mass., with 71 present. The special guest of the occasion was Prof. A. Wilmer Duff, who occupies the chair of physics in the Worcester faculty and who delivered an address on "Wireless Telegraphy." The subject was of peculiar interest because of the part a Worcester Polytechnic student has had in the development of the wireless telegraphic system of the Japanese Government. Professor Miabi, to whom credit is due, was a special student during 1874 and 1875 in the department of physics under the late Professor Kimball. On his return to Japan he became identified with the Imperial University, and is now at the head of the wireless telegraph service of the Japanese Government.

MR. R. H. DERRAH.—An important department in the street railway world has been created by the Boston & Northern and the Old Colony Street Railways, of Boston, in the form of a passenger department. Mr. Robert H. Derrah has been appointed passenger and advertising agent of the two companies. This is the first office of its kind in the country. Mr. Derrah is well known to the street railway fraternity on account of his efficient work throughout New England in creating pleasure travel on the trolley lines. He has been a street railway man for 15 years, starting as clerk in the president's office of the West End Street Railway (now the Boston Elevated Railway), acting as private secretary to the Hon. Samuel Little, when president of the former company. Here he made the first map of any state of the Union showing the existing and projected street railway lines, and later he completed similar maps of the states of Rhode Island, Connecticut and New York. He was the originator of the trolley trip from Boston to New York. The two companies he represents operate 800 miles of street railways, north and south of Boston, extending from Nashua, N. H., through the entire state of Massachusetts to Providence and Newport, R. I., serving some 22 cities and 66 towns with a total population of over 2,000,000.

Trade Notes.

THE CRESCENT COMPANY, Chicago, has just issued a very neat catalogue describing the "All Metal" electric signs manufactured by the Haller Machine Company, for whom it is sole selling agent.

GRAND PRIZE FOR ELECTRIC CARBONS.—The St. Louis World's Fair has awarded a grand prize to "Electra" Nuernberg carbons, of which Hugo Reisinger, 11 Broadway, is the American agent.

DIXON BLOTTER.—The blotter issued by the Joseph Dixon Crucible Company, Jersey City, N. J., is quite apropos of the present season, having a football player in one corner, a turkey in another and calendar for the month of November in the center.

THE AMERICAN WATER SOFTENER COMPANY, of Philadelphia, has been compelled, by its constantly increasing business, to move into more commodious offices, and combine the laboratory with the general sales department. It now occupies a large suite of offices in the Mutual Life Building, 1011 Chestnut St., Philadelphia.

ALBERGER BAROMETRIC CONDENSERS are the subject of a handsome catalogue, No. 4, issued by the Alberger Condenser Company, 95 Liberty Street, New York City. The pamphlet contains a great deal of information never before published, as well as many new cuts—halftones, diagrams, etc. The technical discussion of the subject is admirable. The Alberger apparatus received a grand prize at the Universal Exposition, St. Louis.

A TALK ON NEGOTIABLE SECURITIES.—With this catching title the F. Bissell Company, Toledo, O., has issued a folder describing various "security" devices, including manhole tops and guards, conduit rods, section insulator, pole seats, alley braces for side-arms, etc. The same company has also issued a "Hand-book of Switchboards" in which complete boards and numerous forms of panels for 2500 amperes or less are illustrated and described.

THE ELECTRIC CONTROLLER & SUPPLY COMPANY, of Cleveland, Ohio, announces that it has been awarded a gold medal for its St. Louis World's Fair exhibit. The apparatus shown consists of a full line of its regular controllers for crane, charging machine and similar service—a working exhibit of a magnetic switch controller built for motors of any horse-power; a magnetic friction and stop brake; cushion type solenoids; electric lifting magnets for plates, billets, etc.; resistance banks; knife switches and a working exhibit of its direct-connected variable speed motor drive for planers.

THE GEORGE F. BLAKE MANUFACTURING COMPANY has just published a new edition of its general catalogue, the 150 pages of which describe and illustrate steam pumps for every possible service, including boiler feeders, auxiliary apparatus for steamships, mining pumps, sugar house machinery, water works pumping engines, vacuum pumps, air pumps and condensers, artesian pumps, brewery and distillery pumps, high pressure pumps, acid pumps, etc. This company states that it has recently added to its plant an entirely new machine shop and foundry, equipped with the most modern tools. The catalogue will be sent upon request.

McCULLOUGH-DALZELL CRUCIBLE COMANY, Pittsburg, Pa., has just completed the erection of a new dry house. The new building is admirably constructed for its purpose and is complete in its every detail. It comprises a series of deep pits, flanked by enormous furnaces. Into these pits the imported clay—from Klingenber, in Germany—is cast, to be exposed to the heat of the furnaces for a certain time. The drying process is an important factor in crucible making—after quality of the plumbago and clay is considered. Natural gas is the fuel used here, as elsewhere in the works, for heat and power. The McCullough-Dalzell Crucible Company reports an encouraging growth of new business during the year.

JAPANESE SOLDIERY.—One of the recent sensations at Proctor's Twenty-third Street Theatre was the appearance there of the Imperial Japanese Guards, composed of reservists of the Mikado's imperial forces. They appeared in duplicates of the field uniforms of the Japanese infantry and gave a fine exhibition of the peculiar tactics patterned after those of European armies, but given Oriental individuality. They are actual soldiers who have taken this practical way of serving their cause. A large body of men at present in this country studying the English language are waiting in Seattle and San Francisco to obtain transportation to Japan. The money made by this exhibition company is forwarded to their fellows upon the Pacific slope and is used to defray their expenses to Japan. Another important novelty was the introduction to vaudeville of Zaynard's Midgets, direct from the St. Louis Exposition, where they were one of the real attractions upon the "Pike" all summer. It is a complete troupe of entertainers in miniature, offering a diversity of amusement in which the tiny performers closely approximate the cleverness of their larger rivals. Fully thirty new acts of importance are listed for Proctor appearances before Christmas, including the revival of "The Queen's Fan," which was first shown at Proctor's Fifth Avenue Theatre election week. This was done with new scenery by Unitt, and with new music written by A. Baldwin Sloane. Oriska Worden and Adele Archer appear in the company.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOVEMBER 8, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

774,158. PROTECTIVE DEVICE FOR ELECTRICAL CIRCUITS; Frank B. Cook, Chicago, Ill. App. filed Nov. 13, 1903.

774,160. SELF-SOLDERING THERMAL PROTECTOR; Frank B. Cook, Chicago, Ill. App. filed March 26, 1904.

774,163. BRUSH HOLDER FOR ELECTRIC GENERATORS; Isidor Deutsch, Montreal, Can. App. filed May 14, 1903. The brush-holding arms move parallel to the commutating plane, the bearings of the arms being arranged at right angles to the axis of the commutator, whereby the brushes will be in the proper commutating position, no matter how much worn.

774,181. ELECTRIC INTERRUPTER FOR HIGH FREQUENCY CURRENTS; George E. Johnson, Fort Wayne, Ind. App. filed Dec. 7, 1903. A number of water-cooled tanks having upon their adjacent faces hollow spark-gap points which are kept cool by the circulation of water in the tank.

774,202. ELECTRICAL CONNECTION; Frank J. Russell, New York, N. Y. App. filed Jan. 7, 1904. A special form of contacts for a plug and socket connection.

774,203. DROP CIRCUIT CUT OUT; Frank J. Russell, New York, N. Y. App. filed May 16, 1904. A rosette having clips conveniently located for insertion of a fuse cartridge.

774,230. ELECTROLYTIC APPARATUS; Arthur Brichaux, Brussels, Belgium. App. filed Oct. 4, 1898.

774,250. SEPARABLE ATTACHMENT PLUG; Harvey Hubbell, Bridgeport, Conn. App. filed Feb. 26, 1903. A base to which the cord is connected is provided with pin contacts adapted to enter either an Edison or a Thomson-Houston plug.

774,251. SEPARABLE ATTACHMENT PLUG; Harvey Hubbell, Bridgeport, Conn. App. filed May 27, 1904. Details.

774,283. APPARATUS FOR TELEPHONE TRUNK-LINES; Edwin H. Smythe, Freeport, Ill. App. filed April 27, 1903.

774,313. APPARATUS FOR CONTROLLING MOVABLE PARTS OF RAILWAY SUPERSTRUCTURES; Frank Lemont Dodgson, Troy, N. Y. App. filed Jan. 17, 1901. Railway signals are operated by pneumatic valves and pressures under control of electro-magnets.

774,318. MANHOLE TERMINAL FOR CONDUIT SECTIONS; Guy M. Gest, Cincinnati, Ohio. App. filed July 12, 1902. The terminal section of a conduit is surrounded by a frame having rounded surfaces over which the cables are dragged in passing into or out of the conduit.

774,320. ELECTRIC SIGNAL; Frederick H. Gray, Leavenworth, Kan. App. filed Feb. 1, 1904. Details.

774,342. BURGLAR ALARM SYSTEM; Harold D. Stroud, Chicago, Ill. App. filed Dec. 22, 1902. A phonograph is turned loose at the protected locality and speaks into a telephone transmitter, the message being received by telephone at the central station.

774,373. STREET RAILWAY SWITCHING MECHANISM; Walter J. Bell, Los Angeles, Cal. App. filed May 21, 1903. The switch tongue is moved by pneumatic pressure controlled electrically from the car.

774,385. AUTOMATIC FIRE ALARM; John W. Griffin, Pawtucket, R. I. App. filed March 23, 1904. A spring plunger is held in open circuit position by a small block of fusible material.

774,391. HOLDER FOR ELECTRIC INCANDESCENT LAMPS; Peter Kleber, Wiesbaden, Germany. App. filed July 9, 1903. A lamp receptacle in two telescoping parts with a spring between them arranged so that the contacts are always pressed together when the lamp is in the receptacle.

774,404. BASE FOR INCANDESCENT LAMPS; Alfred Swan, New York, N. Y. App. filed April 1, 1901. The end of the shell is closed by a web of glass inserted in liquid state so as to solidify around and closely unite the shell and center contact.

774,436. CIRCUIT CLOSING DEVICE; Harry T. Johnson, Jersey City, N. J. App. filed April 2, 1904. A flat series of plates adapted to be placed under a rug and arranged in a circuit so that pressure upon the rug will close the circuit and give an alarm.

774,460. RHEOSTAT; Montgomery Waddell, New York, N. Y. App. filed Nov. 25, 1903. The resistance elements are independently supported upon springs and have to be pushed together one after the other in regulating the resistance of the circuit.

774,463. WINDOW SPRING; Charles E. Avery, Jersey City, N. J. App. filed April 12, 1904. Details of a burglar alarm circuit closer.

774,469. BINDING-POST; Harry J. Guttman, Chicago, Ill. App. filed May 4, 1903.

774,481. RAILWAY SIGNAL SYSTEM; Oscar J. Lee and Myron H. Richardson, Chicago, Ill. App. filed June 2, 1902. A third wire is run in connection with two main wires of a circuit; signals are connected across at intervals between the third wire and one main wire and circuit closers are connected across the third wire and the other main wire at points adjacent the signals respectively.

774,494. SPEED CONTROL OF ELECTRICALLY PROPELLED VEHICLES; John S. Raworth, London, Eng. App. filed June 5, 1903. An interlocking means is used to prevent the making or breaking of the armature circuit of the motor until the controlling device for the shunt field is in a certain position.

774,498. AUTOMATIC INTERLOCKING SIGNAL SYSTEM FOR RAILWAYS; Benton C. Rowell, Chicago, Ill. App. filed May 19, 1900. Details.

774,506. INSULATED RAIL JOINT; Christian J. Buck, Gallitzin, Pa. App. filed May 12, 1904. A novel construction of the splice bars and their arrangement with respect to the meeting ends of the rails.

774,524. TROLLEY GUARD FOR ELECTRIC RAILWAYS; John Kress, New Rochelle, N. Y. App. filed March 16, 1904. The trolley guard is so connected by means of the rod and pivots with the base of the pole, that it is held in a vertical position regardless of the incline of the pole.

774,525. CONDUIT THREADING MACHINE; Ernest U. Mack, Florence, S. C. App. filed April 23, 1904. A spring motor in the body of the machine drives gearing and traction wheels to carry the machine through the conduit.

774,529. ELECTROTHERMIC AND VACUUM APPLIANCE; Charles C. F. Nieschang, Fort Wayne, Ind. App. filed Aug. 29, 1904. A dome-shaped body to be applied to various organs of the human body to develop the same, having means for creating a vacuum within it and a socket for a lamp, so that treatment by light rays and vacuum can be carried on simultaneously.

774,534. TROLLEY; John W. Rockafellow, Sergeantsville, N. J. App. filed Aug. 18, 1904. Details.

774,543. PARTY-LINE TELEPHONE SYSTEM; Felton Vollmer, Winsted, Minn. App. filed Nov. 20, 1903.

774,608. ATTACHMENT FOR PARTY-LINE TELEPHONE SYSTEMS; William Alsa Shackleford, Lexington, Ga. App. filed Dec. 3, 1903.

774,611. ELECTRICAL COUPLING; Frank J. Sprague, New York, N. Y. App. filed July 7, 1900. A pair of mating couplers each consisting of a supporting casing, an insulating body and a protecting casing; the contacts are held by the insulating body and a cover for one of the casings serves as a latch between the couplers.

774,618. ELECTRICALLY OPERATED BLOCK SIGNALING APPARATUS; Charles W. S. Turner, Mountville, Va. App. filed Dec. 22, 1903. Details.

774,619. SAFETY ATTACHMENT FOR LOCOMOTIVES; Charles W. S. Turner, Mountville, Va. App. filed Dec. 22, 1903. Improvements in the details of a system wherein the steam is cut off and the air brakes applied on a locomotive approaching too close to another on the same track.

774,620. RAILWAY SIGNALING APPARATUS; Charles W. S. Turner, Mountville, Va. App. filed Dec. 22, 1903. A network of wires is arranged about the track structure and connected in circuit with signal stations along the line in such manner as to indicate the exact location where a washout, landslide or other catastrophe disabling the track occurs.

774,623. FLEXIBLE ELECTRIC HEATER; Samuel S. Wales, Munhall, Pa. App. filed April 30, 1904. The heating resistance is attached to thin strips of cloth which are temporarily fixed upon a blanket, so that they can be removed when desired and the blanket cleaned.

774,624. ELECTRIC CIGAR LIGHTER; James Waters and Frederick V. Thompson, Philadelphia, Pa. App. filed April 15, 1904. A device having the shape of a telephone receiver is fitted with electrodes, a switch and a source of current to be used as a cigar lighter.

774,668. BURGLAR ALARM; Harry T. Johnson, Jersey City, N. J. App. filed April 2, 1904. Details of a window spring.

774,669. HANGER FOR ELECTRIC ARC LAMPS; Walter J. Jones, Newark, N. J. App. filed May 24, 1904. The hanger carries a pair of springs connected with the two binding posts which deliver current to the lamp when it is attached to the hanger; the removal of the lamp allows the springs to come together and close a short circuit.

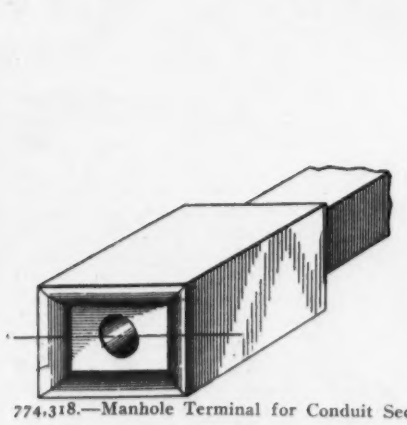
774,693. STEERING APPARATUS FOR SHIPS; John Peterson, Abenia, N. Y. App. filed July 11, 1904. Contacts are arranged to co-operate with the needle of a compass and electric steering gear in such a manner that when the ship deviates from its course, the steering gear will be actuated properly to return it to its course.

774,701. ELECTRIC ILLUMINATING ARRANGEMENT FOR RAILWAY VEHICLES; Friedrich W. Schneider, Frankfort-on-the-Main, Germany. App. filed Sept. 15, 1902. Mechanical devices actuated by a governor are utilized to maintain a constant voltage in a system where the dynamo is driven from a car axle.

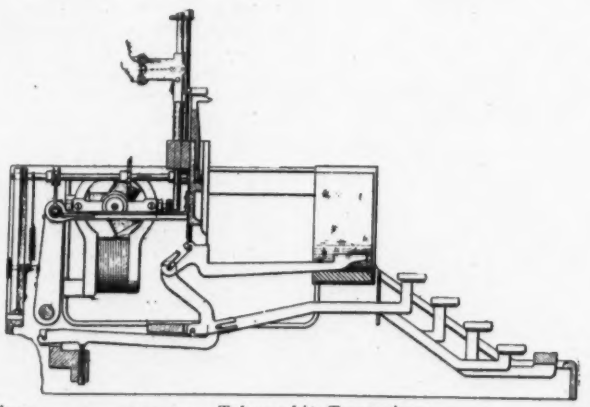
774,717. RAILWAY TRAFFIC CONTROLLING APPARATUS; Clyde J. Coleman, Rockaway, N. J. App. filed April 11, 1904. A thermal-electric generator and a motor are mounted in a frame beside a semaphore; the train closes the circuit of the generator and the current actuates the motor to move the signal.

774,724. TELEGRAPHIC TRANSMITTER; Alfred C. Gilmore, Chicago, Ill. App. filed Oct. 14, 1904. The transmitter embodies a common transmitter switch, a series of independently mounted signal type movable to and from a common position to co-operate with the switch and a series of finger-key shifters corresponding to and selectively operating the type.

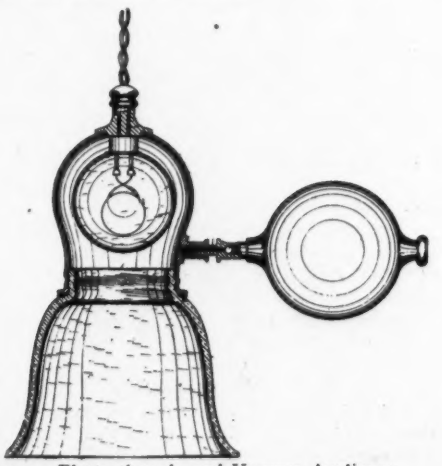
774,728. LIQUID CONTACT CHAMBER FOR ELECTRICALLY WOUND MECHANISM; Percy L. Clark, Bristol, Conn. App. filed Dec. 2, 1903. A contact chamber containing a drop of mercury, is fitted with a dam which retards the movement of the mercury until the chamber has tilted to a certain point, when it is allowed to pass the dam en masse and quickly close the circuit.



774,318.—Manhole Terminal for Conduit Sections.



774,724.—Telegraphic Transmitter.



774,529.—Electrothermic and Vacuum Appliance.

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In January, 1898, the Weston Electrical Instrument Company entered suit against us in the U. S. Circuit Court for the Southern District of New York, alleging infringement of patents Nos. 11250 (reissue) and 470340 which patents claimed to cover broadly the principle and structure of direct and alternating current voltmeters and wattmeters constructed upon the principle of the electro-dynamometer.

In December, 1902, Judge Coxe held the Weston patents to be valid and the Keystone instruments an infringement thereon. An injunction thereupon issued and for nearly two years we have been denied the right to manufacture this type of instrument.

Immediately upon the issuance of Judge Coxe's decree we appealed from his decision and in May, 1904, argued our appeal in the U. S. Court of Appeals. In November, 1904, the Court of Appeals handed down an opinion by Judge Townsend and concurred in by Judges Wallace and Lacombe in which the decision of Judge Coxe is reversed, the Weston patents, Nos. 11250 (reissue) and 470340, declared invalid and the injunction vacated.

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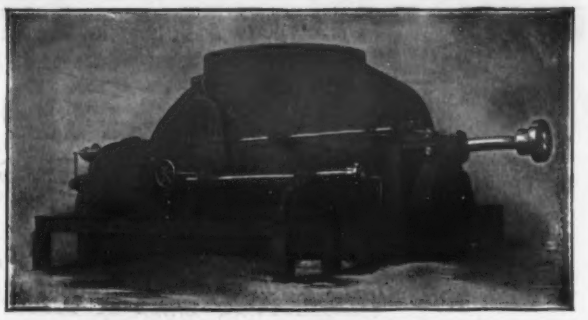

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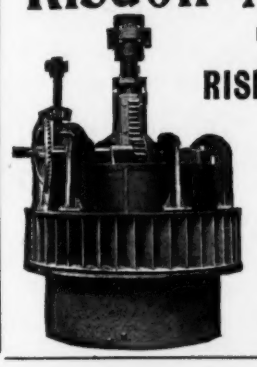

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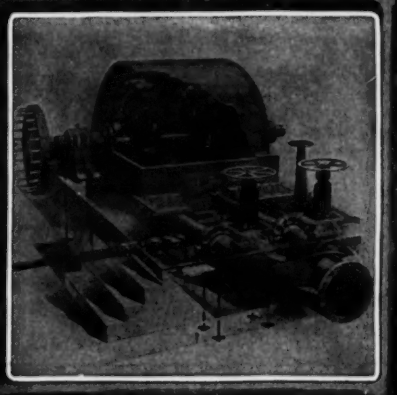

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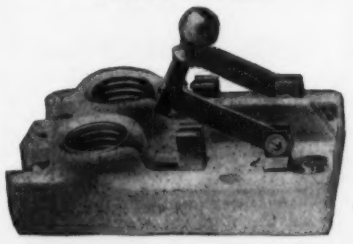

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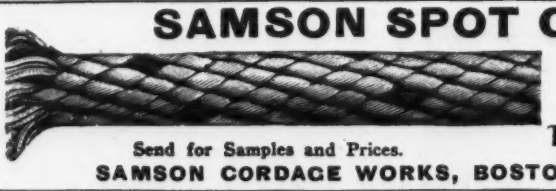

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